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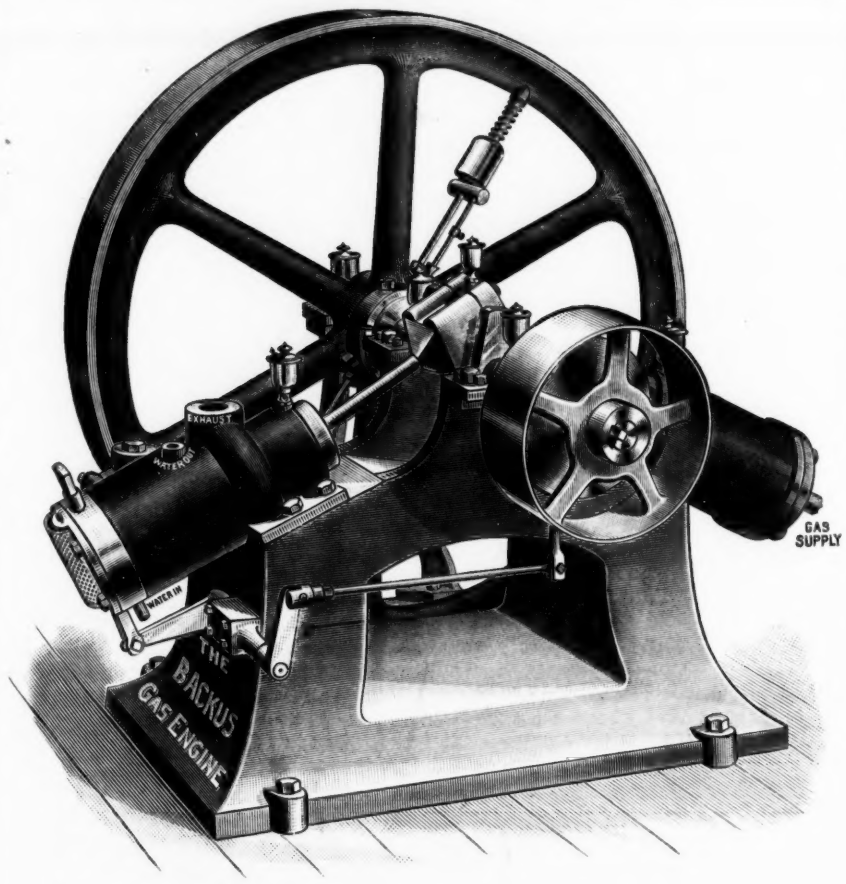
The Backus Gas Engine.

We present on this and the next page engravings showing the construction of a new gas engine, which in its method of governing, and in other details of construction, will be found to contain points of interest.

As will be seen by the engravings, the frame of the engine is of a modified A form, with the crank-shaft at the top, and there are two cylinders of equal size, which are inclined, the one at the left being the working cylinder, while the one at the right is a pump in which the mixture of gas and air is first received and compressed by the pump piston, after which it passes through a large pipe connecting the two cylinders, and is admitted to the working cylinder by a poppet valve, the opening of which is controlled by the governor. Gas is admitted to the compressing cylinder by a pipe which enters the head, and air enters through a number of holes which are made in the head around the pipe, as shown by the end view of this head at the right of Fig. 1. The holes through which air enters are covered by a valve which is opened by atmospheric and seated by the pressure within the cylinder. The proportions of gas and air are controllable by a valve in the gas supply pipe.

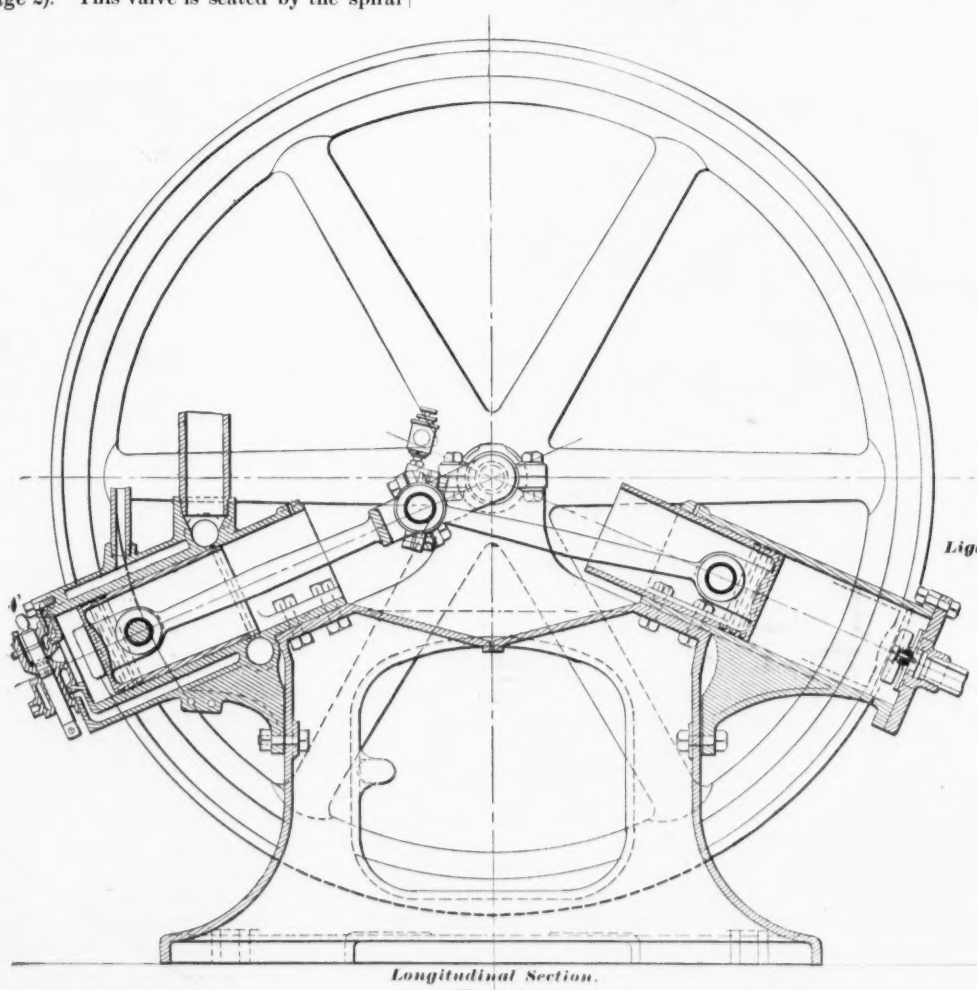
Near the working cylinder, and in the large pipe which joins the two cylinders, is a poppet valve having a stem projecting through a stuffing-box below, as shown at Fig. 3 (page 2). This valve is seated by the spiral spring shown, and is lifted to admit the explosive mixture to the cylinder by the lever shown below, which is pivoted to the side of the frame, and receives its motion from an eccentric which is located just inside the fly wheel, as shown in section at Fig. 2, and a side view in Fig. 4. This eccentric is in two parts joined together by a hinge joint at one side, one of the parts being secured to the end of the hub of the fly wheel by screws as shown, while the other is free to move upon the hinge joint to give greater or less eccentricity, its tendency to fly outwards being resisted by the spiral spring shown.



The amount of eccentricity is then controlled by the wedge seen at the left of the eccentric in Fig. 4, and under it, in Fig. 2, this wedge being attached to one of the arms of the fly wheel, and its distance from the center of the shaft controlled by the opposing forces of the spiral spring shown behind it, on the one hand, which tends to force it inwards and open the eccentric, while upon the other is the centrifugal force of the weight under the spring, which tends to withdraw the wedge and allow the eccentric to close. A half strap fits in the groove of the eccentric below, from which, by the connections shown in Fig. 3, the valve is moved, and admits more or less of the mixture to the cylinder, according to the requirements for the work being done, an explosion taking place at every revolution where needed, and yet leaving a margin for governing.

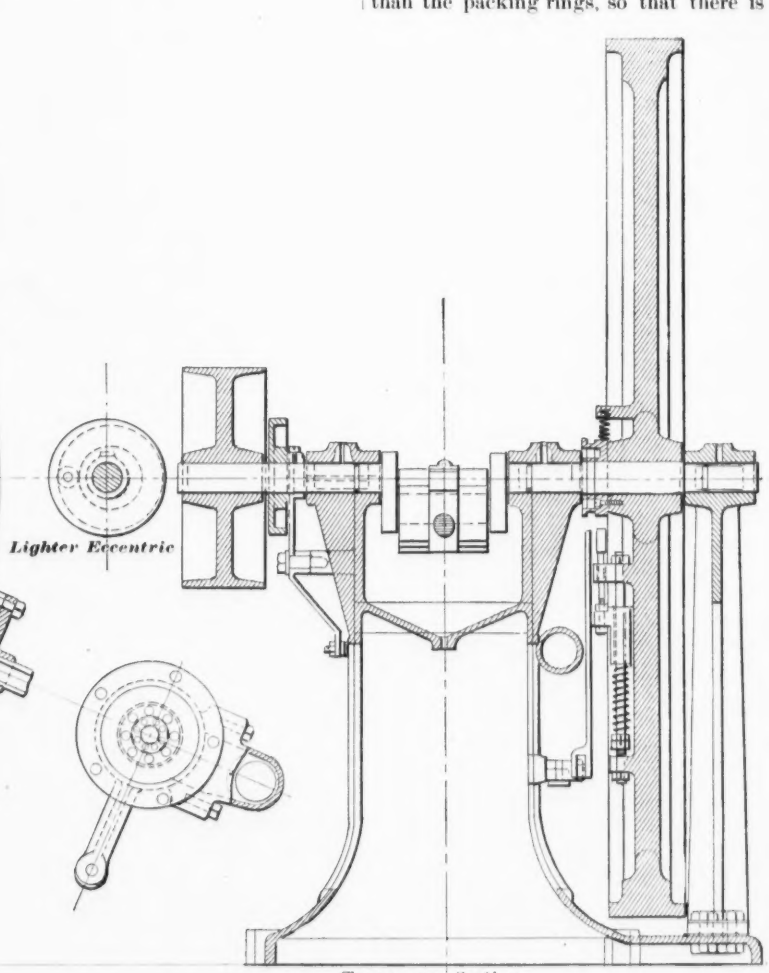
There is no exhaust valve, but towards the upper end of the cylinder there is a narrow opening or port, which passes entirely around the inside of the cylinder, and connects with the large passage seen, which also extends around the cylinder, and at the top is connected with the exhaust pipe as shown. The piston passes over this port at the end of the stroke, and exhaust takes place. The port, though of large area to give a free exhaust, is considerably narrower than the packing rings, so that there is no trouble from the rings entering and catching in it.

The lighter is seen at the left of the working cylinder, Fig. 1, and is operated by a



Longitudinal Section.

Fig. 1.



Transverse Section.

Fig. 2.

THE BACKUS GAS ENGINE.

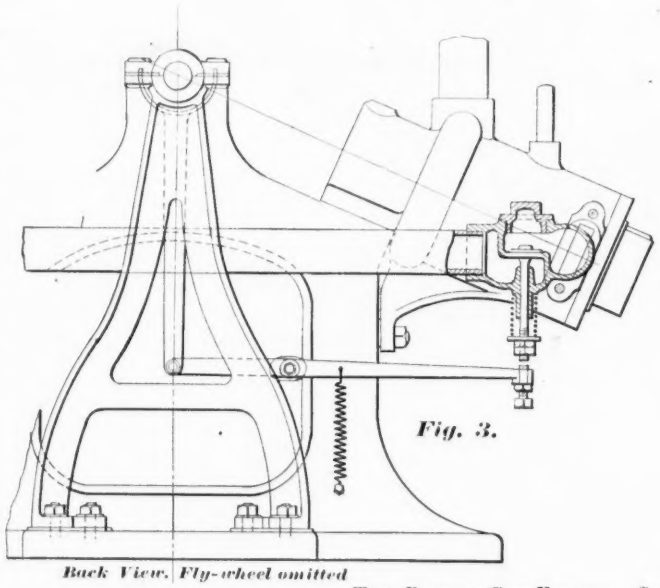
cam placed on the crank-shaft just inside the belt pulley.

A small jet of gas is kept burning, and a cylindrical valve operates to give communication with the contents of the cylinder at the beginning of the stroke.

Provision is made for cooling the cylinder by circulation of water, as shown, and also for thorough lubrication.

It has been found by experiment that the regulation is all that could be desired, and there is no trouble in starting the engine at any time.

The engines have been built in sizes from ½ to 3 horse-power, and are to be built up to 25 horse, by the Backus Water Motor Co., Newark, N. J.



Back View. Fly-wheel omitted

Fig. 3.

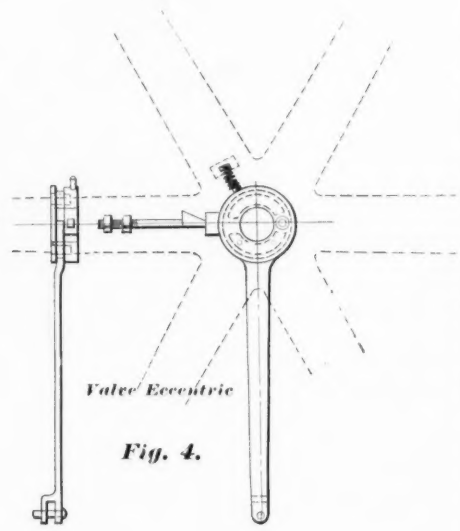


Fig. 4.

THE BACKUS GAS ENGINE.—SEE PAGE 1.

The Thermal Action of Steam Engine Cylinder Walls.

The following abstract of a paper by Professor Dwelshauvers-Déry, of Liége University, in which is described some instruments designed by Mr. Bryan Donkin, Jr., for showing the thermal action of cylinder walls, will, we think, be of interest to our engineering readers. The paper appeared in the August number of the *Bulletin de la Société Industrielle de Mulhouse*, 1890.

From the first employment of steam as a motive power an apparatus has been in use to indicate the varying pressure of steam in an engine cylinder. The necessity of gauging the action of the steam was apparent to Watt himself, and the instrument devised by him for this purpose has since, with few modifications, been universally adopted. No arrangement, however, was considered requisite to show the temperature of the cylinder walls. Until a comparatively recent period scientific men maintained that the influence of this temperature upon the steam, though strenuously insisted on by Hirn and others, was so slight that it might be neglected, and the subject was usually ignored. Within the last few years, however, instruments have been invented, by means of which it is possible to study the temperature of the cast-iron walls, and to show their influence. The small apparatus originally designed was merely a transparent prolongation of the cylinder walls. It consisted of a boiler glass water gauge affixed to the indicator cock, the steam from the cylinder passing through the cock into the tube. But it was soon found that a single tube, though exhibiting all the phenomena of condensation and re-evaporation, could not protect the steam from the effects of radiation, and therefore afforded no true index of what was taking place inside the cylinder. A second outer glass tube or cylinder was therefore added, and a layer of air left between the two. Both glass cylinders were vertical, and fixed between horizontal metal plates. The next modification in the apparatus was that of prolonging the pipe conveying the steam from the engine, and making it project a certain distance above the bottom of the inner cylinder, in order that a small quantity of water, about ¼ in. deep, might be deposited in the space thus formed. When the apparatus was placed on the high-pressure cylinder of a compound engine, with a boiler-pressure of five atmospheres, $\frac{5}{6}$ths of this water disappeared as steam in two minutes, but the remaining $\frac{1}{6}$th evaporated very slowly. On the low-pressure cylinder the water almost disappeared in three or four minutes, boiling strongly during the exhaust period, but the bottom of the inner cylinder never seemed to be absolutely dry. When placed on the condenser scarcely ¼ in. was evaporated in several hours, owing to the low temperature of the apparatus.

In the following year two improvements were made in the instrument. Metal was now used for the inner cylinder, and a current of cold water was introduced into it from a reservoir above. Steam from the engine cylinder was admitted into the annular space between the inner metal and the outer glass cylinders. By varying the temperature of the water the temperature of the inner cylinder could be changed at will, and read from a thermometer placed for that purpose in the wall. The remarkable heat effects produced by the steam on the walls of different temperatures were plainly visible through the outer glass tube. When the inner cylinder walls were allowed to assume a temperature considerably below that of the steam, large drops of water formed on both the glass and metal surfaces. The higher the temperature of the inner walls the smaller the size of the drops of condensed water, and when the inner cylinder was heated to the same temperature as the initial steam no dew whatever was visible. But as long as neither the thickness nor the composition of the walls of the inner and outer cylinders corresponded with those of a steam engine, comparative results could not be obtained. A new instrument was therefore made of cast-iron, having the same thickness as the walls of an ordinary cylinder. The space between the two was filled with steam from the boiler, forming a steam jacket, and the inner cylinder was connected with the steam from the engine. Holes were drilled in the inner walls, spaced out at regular distances in the thickness of the metal, and filled with mercury, into which small thermometers were plunged. The degrees of temperature marked by these thermometers were combined into diagrams representing the thermal gradients. By these means careful observations could be made of the propagation of heat through the walls, and the exchange of heat between the metal and the steam. The thermometers showed that this heat does not follow the same course throughout the metal. The thickness of the wall may be divided into two parts, the inner portion comprising about $\frac{1}{10}$th and the outer about $\frac{9}{10}$ths of the total depth of the metal. In the region next to the piston the temperature fluctuates continually; it may be called the intermittent or periodic thickness, because the thermometer proves that in this part the heat goes in and out of the wall at every stroke. In the outer region, comprising the greater part of the thickness of the wall, the temperature is practically constant, and the heat radiates continually outwards from the dividing limit which separates it from the inner or periodic portion. Thus we get two movements of the heat, an action fluctuating in both directions through the inner $\frac{1}{10}$th, and an outer radiating action through the remainder of the thickness. At the boundary the surplus heat accumulates; it is sometimes restored to the inner surface, and sometimes receives from it a fresh store of heat. The farther the metal is from the steam, the less its temperature fluctuates. The inner cylinder has also been fitted with a small piston to keep the surface clean and imitate as far as possible the working of an engine cylinder. The space between the cylinders forming the jacket is drained by two pipes; the water condensed on the outer surface of the inner cylinder, and on the interior surface of the outer cylinder, is drawn off separately. By this arrangement the total quantity of jacket water is divided into two portions, and the heat effects of each surface can be measured. —*Industries.*

A Level-headed Boy.

A boy about 15 years of age applied to a factory in Atwater street for the job of running a small engine in the place of a boy who had quit.

"Have you run an engine?" was asked.

"Yes, sir."

"You understand how steam works, do you?" "I do."

"You know that water makes steam?"

"Of course."

"How is water got into a boiler?"

"By an injector."

"Suppose you have too much water?"

"Then I can't get steam enough until I draw it down."

"Correct. Suppose you haven't enough?"

"Then look out for an explosion."

"Correct again. Suppose you found the water almost gone, and couldn't start the injector—what would you do?"

"Come up-stairs and notify you to get your insurance policies out of the safe and make a sneak before she busted!"

"You seem to be all right, young man; you can come on in the morning."—*Detroit Free Press.*

Sketches of an Apprenticeship.

BY W. S. ROGERS.

Of course my chum Johnnie and myself had our aims and ambitions in life, just as all other cubs, and at odd times built and elaborated our youthful castles in the air. Johnnie's main object in life was to have a shop of his own, where he could bring in lots of work and keep scores of men busy. His parents were so situated that his air castles seemed to have good foundations. My sole aim was to learn every item and detail about the construction and running of a locomotive, but as I was not in a locomotive shop my prospects were not so brilliant, and my chum had about persuaded me to go in partnership with him, and as a beginning we had bought an old foot lathe with some turning chisels, and had stored them in the woodshed at home while waiting for something to turn up.

It was not long before we grasped the idea of making base-ball bats. They were just in season and sold in the stores for twenty-five cents each. There certainly must be lots of profit in them, we reasoned, and we could sell them to the boys direct for fifteen cents each, and there would be big dividends in the business for us. We got a lumber dealer to trust us for fifteen dollars worth of cedar and willow, on the strength of our parents' reputation, and we went into business. Every night after supper we took turns at that old foot lathe, and thought it fortunate there were two of us in partnership, otherwise the shop would have stood idle half the time while the other one mopped up the perspiration. Meantime we had laid our project before the Old Man who encouraged us, and advised us to keep an account and let him see our "dividend" sheet, as it was just as important to know business methods as it was mechanical methods, to insure success, and possibly he could advise us.

Well, at the end of a month we had made and sold (on credit mostly) one hundred bats. Business seemed good, but finances didn't seem to figure to suit us, and we were getting weary of it. Here are the items we presented to our preceptor when we had concluded to "dissolve":

EXPENSES.

Foot lathe and tools	$11.50
Lumber	15.00
Sand-paper	.25
Lamps and oil	1.30
Paint and shellac	.90
Brushes (two)	.30
Total	$29.15
Money we owe	$15.30
Money owed us	10.50
Money we have	2.45

We showed the above to the Old Man when we went to our Friday night drawing lesson.

After looking it over and smiling, he asked, "How much of your outstanding bills can you collect?" "Don't think we can get any," we answered. "What have you learned by your experience, John?" he asked. "How to make bats," replied Johnnie. "And you, Rogers?" he questioned, turning to me. "That pumping a foot lathe is hard work," I answered. "Anything else?" he asked. "No, we want you to tell us."

"All right," the Old Man said. "Now listen, for there are plenty of grown men going through the same experience to-day, and can't tell what ails them. They go on for a few years with seeming prosperity, having good collections, etc., when suddenly times get hard, money can't be raised, and they fail, make an assignment to avoid paying their creditors, and lay the blame to dull times, instead of their own inability to figure cost of production and marketing their wares, and poor judgment in doing business. Now let us count this up differently, and see how it will look:

ORIGINAL INVESTMENT.

Machinery and materials	$29.15
Labor, time, etc.	20.00
Total cost, one month	$49.15
Cash received	$ 4.50
Disbursements	2.05
Cash on hand	$ 2.45
Value of tools	12.95
Available assets	$15.30
Liabilities	$15.30
Dead loss, if the lesson is of no value	$23.85

"Now, sell off your stuff for $12.95; pay your debt; spend your evenings in future reading mechanical works and improving your minds socially—and by "socially" I don't mean that you should attend balls until four o'clock in the morning, and then come round to work half asleep next day, as a good many cubs do, I am sorry to say—watch how we do business in this shop, and notice other shops, comparing all with your recent business venture, and it will be a profitable lesson in the end."

Dr. R. W. Raymond, secretary of the Mining Engineers, is absent in the Mediterranean and the Nile regions, to take a much needed rest. During his absence W. B. Kunhardt is acting secretary.

Twenty-five-inch Drill Press.

The accompanying cut illustrates a drill press, the principal distinctive feature of which is the absence of the usual sleeve for the spindle by which vertical motion is imparted to it, and the performance of its functions by the sliding of the head upon the face of the column.

This, of course, gives an increased feeding capacity, so that deep holes may be bored continuously by automatic feed. The 25″ size is illustrated, and in this case the spindle is fed automatically 23″.

By means of a lever and rack and pinion movement, the head may be very quickly raised after boring or drilling is completed, or placed in any position upon the column. The quick return can be used without stopping the power feed. The spindle is made of crucible steel, with bearing 1⅝″ diameter. Cone pulleys are for 2½″ belt; driving pulleys, 12″ diameter, 3″ face; total weight of machine, 1,500 pounds. These drills are built in sizes from 22″ to 36″ inclusive, by J. E. Snyder, Worcester, Mass.

Launch of a Tugboat from the Yards of Samuel L. Moore & Sons Co., and Other Vessels in the Course of Construction.

On the 3d inst., an iron tugboat for the New York, New Haven & Hartford Railroad was successfully launched from the busy yards of Samuel L. Moore & Sons Co., Elizabethport, N. J. Length of boat is 100 feet; beam, 22 feet; depth, 12 feet. The frames are made of 3½x3½ inch angle iron, placed at 21 inches between centers; the reverse frames are made of 2½x2½ inch angle iron; average thickness of plates, one-half inch. A compound engine is to be placed in the boat; diameter of the high-pressure cylinder, 20 inches; low-pressure cylinder, 40 inches; stroke of both, 26 inches. The boiler will be nine feet diameter, 15 feet long, and will carry a working pressure of 125 pounds.

The yards of Messrs. Moore & Sons are well equipped with first-class machinery for building large as well as small iron or steel vessels, and have all the facilities for turning out good work on time. Besides another, two iron tugboats, which are nearly ready for launching, for the same railroad company, a keel is being laid for the Pennsylvania Railroad ferryboat "Cincinnati," of the following dimensions: Length (molded,) 180 feet; beam (molded,) 46 feet; length over guards, 204 feet; beam over guards, 65 feet; depth (molded,) 16 feet, 6 inches.

The keel for the U. S. Practice cruiser will be laid soon; and a composite tugboat for the Pennsylvania Railroad will also be soon in the course of construction. The dimensions of this tugboat are as follows: Length between perpendiculars, 81 feet 2 inches; length over all on deck, 93 feet; beam outside of planking, 20 feet 6 inches; beam outside of guards, 21 feet 8 inches; depth (molded,) 10 feet 8 inches.

Considerable work is also under way of construction in the machine shop, which is equipped with all the modern tools, and well arranged, including a first-class toolroom for building marine and stationary engines, and other classes of machinery. Among the work in hand we noticed several straight line engines, including a compound engine of the same type.

Rope Driving.

BY W. H. BOOTH.

In the report of the recent meeting of the Mechanical Engineers at Richmond there appears a paper on rope driving.

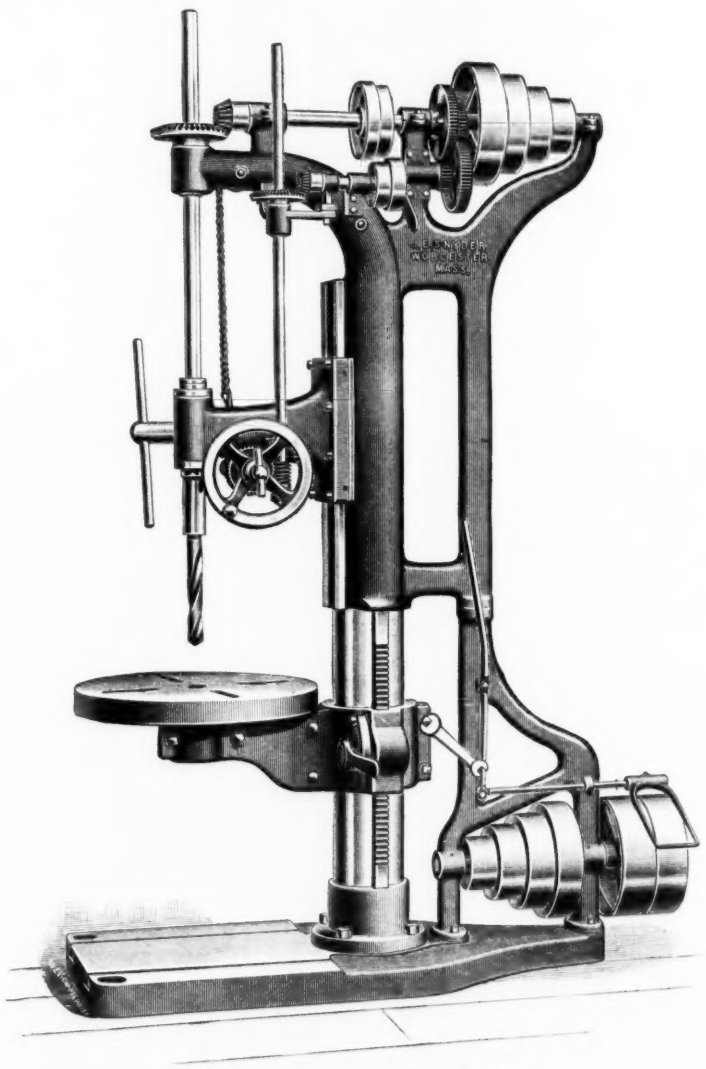
In the discussion a member stated that in England, where rope driving had attained its highest development, cotton had been proved the best material of which ropes should be made.

Cotton is certainly the most usual material, but, though it may be the best, also, it is not because it is the best that it is so much used.

The most probable cause for the preponderance of cotton is that rope driving is most common at cotton factories, and cotton ropes, made in the locality from the local product by makers who had for years been making spindle bands, and mule or rim bands of small size, applied themselves to the newer industry for obvious reasons, and shut out the hemp ropes and flax. In Dundee, where flax and hemp are worked, I believe they still use ropes of local make. Cotton is exceedingly extensible, and new ropes, put on as tight as possible, soon stretch slack enough, and even require taking up before they settle to a state of permanent inextensibility.

The calculation of ropes for their duty has been but little attended to, but it seems to have been generally accepted that the best speed is about 5,000 feet per minute, and at a speed of 4,000 feet it seems to be accepted that a two-inch rope (for this purpose ropes are designated by the diameter of their circumscribing circle) may safely transmit 50 indicated horse-power, or rather the power transmitted from an engine indicating 50 horse-power.

When calculations are made it is usual to assume three causes of stress in a rope:



TWENTY-FIVE-INCH DRILL PRESS.

First, the initial tension, which is equal on both pulling and following halves when at rest. Secondly, the tension due to centrifugal velocity, a cause of stress which has, however, been considerably overlooked, but may be of serious amount. Thirdly, the working stress. That speed is most economical which leaves the product of the third stress and the velocity the largest possible. Now, the working capacity of a rope is a direct function of the velocity, but the centrifugal stress varies as the velocity squared, and though, apart from centrifugality, the speed might be infinite and unlimited, a limit is soon placed by the rapidly increasing centrifugal tension, which outstrips the gain due to speed very quickly. Approximately, 60 miles an hour is spoken of as the economic limit of speed, whilst at 90 miles no further speed would be possible, as all the safe tension would be taken up by centrifugal action.

When more interested than now in rope driving I got out a table for ropes, which I enclose.

I based it on a total tension for 1¼″ ropes of 600 pounds. The weights per foot are those given to me by a rope maker of repute.

In the table are given the centrifugal tensions for various speeds up to 120 feet per second. The initial tension was assumed at $\frac{1}{10}$ the total allowed stress, and corresponds with ordinary practice very fairly. It may be calculated for any special case by the formula for horizontal tension at the vertex of a parabola of known span and dip and weight per unit of length.

If to the value of C (centrifugal tension) given in Table 3, be added the initial tension from Table 2, and the sum be subtracted from total allowable working tension, the remainder will be the net available working tension.

In Table 4 is worked out the net available stress for a speed of 80 feet per second of various ropes, and the consequent horse-power.

A little figuring will show that for various speeds this net stress, if multiplied by the velocity, attains a maximum about 80 or 83 feet per second. Of course the higher we allow the total tension to be, the greater will be the maximum economical velocity.

With the tensions given it is clearly useless to go much beyond 4,800 or 5,000 feet per minute.

My friends, makers of ropes, take 7,000 feet as an outside speed, beyond which no further velocity is allowable, and some other course must be pursued to alter such conditions as call for anything beyond.

For general practice, too, the minimum rope is taken at 1½ inch, nothing less being advisable unless small pulleys are obligatory, the smallest pulley not being less than 30 rope diameters, as there is too severe straining of the outer fibers in passing round the pulleys.

The most usual practice in Lancashire is summed up roughly by the following figures: 1¼″ cotton ropes at 5,000 feet per minute velocity at 50 I. H. P. per rope.

Main driving drums, 30 feet; diameter, 36 feet; length of bearings of driven shafts, 4 diameters; minimum driven pulley, 5 feet diameter.

Of course there is a difference between ropes and belts as regards adhesion.

A belt sticks to its pulley by pure adhesion. A rope grips its pulley by virtue of the wedging action produced by the sloping sides of the grooves in which it runs. This largely adds to the grip, but it adds also to the consumption of power. After some time working ropes bed themselves to the shape of the grooves, excepting some few of them, which constantly rotate and maintain a truly circular section.

To preserve ropes from fraying they are dressed with various compositions.

One I have used consists of black lead (plumbago) and molasses. It preserves the flexibility, adds a smoothness to the surface, whilst preventing wear, and helps to increase grip.

In Yorkshire, square ropes of leather are used, and I have seen a good many steel ropes with a covering of leather washers closely threaded on. That rope is the cheapest which has the lightest weight per unit of strength, as it may be run at the highest rate of speed.

TABLE I.

WEIGHT OF ROPES PER FOOT OF LENGTH.

Diameter of rope =	1¼″	1⅜″	1½″	1⅝″	1¾″	1⅞″	2″
Wt. per ft. = W in lbs.	.5	.6	.72	.844	.98	1.125	1.3

TABLE II.

CENTRIFUGAL TENSION DUE TO VELOCITY.

$$= C = \frac{W V^2}{g}$$

Diameter of rope =	1¼″	1⅜″	1½″	1⅝″	1¾″	1⅞″	2″
Value of C. =	$\frac{V^2}{64}$	$\frac{V^2}{53}$	$\frac{V^2}{44}$	$\frac{V^2}{38}$	$\frac{V^2}{33}$	$\frac{V^2}{28}$	$\frac{V^2}{25}$
Total tension allowable	300	360	430	500	600	675	780
Initial tension.	30	36	43	50	60	67	78

TABLE III.

VALUE OF CENTRIFUGAL TENSION.

Velocity Ft. per sec.	Diameter of Ropes. 1¼″	1⅜″	1½″	1⅝″	1¾″	1⅞″	2″
35	19	23	28	30	39	44	48
40	25	30	36	42	48	57	64
45	32	38	46	55	61	72	80
50	39	47	57	66	76	89	100
55	48	57	69	80	92	108	121
60	56	68	82	95	109	128	144
70	77	93	111	120	148	175	196
80	100	121	145	170	193	228	256
90	126	153	184	213	245	290	325
100	156	190	227	263	306	357	400
110	190	228	275	318	367	432	484
120	225	272	327	379	436	500	576

TALE IV.

NET WORKING TENSION AT 80 FT. VELOCITY.

	170	203	242	280	347	380	446
I. H. P. per rope =	24	28	34	41	49	54	63

In order to keep up the supply of competent men in the engineer corps of the navy, it has been suggested that competent machinists familiar with marine work have conferred upon them warrant rank. The pay and emoluments which go with this rank are about equal to what most chief engineers receive in merchant service, and it is thought this will prove sufficient inducement to attract competent machinists, whose superior knowledge would be valuable on board ship. The pay will range from $1,200 to $1,800 per year.

The Measurement of Power.

BY J. J. FLATHER.

SEVENTH PAPER.

In testing with the Emerson dynamometer the centrifugal force produced in the instrument at different speeds must be first determined and noted, and this force must be deducted from subsequent readings.

While investigating the subject of power transmission as applied to milling machines, the writer constructed an apparatus shown in Fig. 16, by which he proposed to measure the magnitude of the force exerted by the teeth of the cutter, but the results were not wholly satisfactory when applied to a milling machine. Used on a planer, however, a measure of the useful work was readily obtained from the card taken from the indicator attached.

Mr. L. P. Breckenridge, of the Lehigh University, had previously made some interesting experiments with a similar apparatus for determining the pressure exerted by a drill working under similar conditions, and more recently has successfully applied the apparatus to planer tools. (See AMERICAN MACHINIST, August 14, 1890.) The action will be understood by an inspection of the figure. The thrust of the tool acts upon the plunger of the cylinder, thereby forcing the contained oil into the pressure gauge and into the cylinder of the indicator. By a suitable arrangement of cords, the drum of the indicator is made to revolve synchronously with the stroke of the tool or with the work; and as the pencil is forced upwards by the pressure exerted at the point of the tool, it will be seen that a measure of the work performed can be obtained from the card. The gauge is simply a check on the indicator. It is evident that the total work performed cannot be obtained by this means, as the force required to drive the machine itself is disregarded.

To obtain the total work, and at the same time the useful effect, the writer next designed the hydraulic dynamometer shown in Figs. 17 *et seq.* (See page 5). The leading idea of this machine was obtained from an article which appeared in *Industries*, but the details of the present dynamometer are in many respects very different from the one there illustrated. To maintain the lever arm constant, the cylinder through which the transmitting force acts should not be bolted rigidly to the pulley arm, as in the case with the machine just referred to, but should be pivoted in such a manner as to obtain a constant lever arm. The principle of the Flather dynamometer is this:

The pulley L receives the power and is loose on the shaft and free to turn within certain limits. F, secured to the shaft, is belted to the machine to be tested, and carries a cylinder c, which is supported on trunnions by means of the brackets b; this cylinder is partially filled with oil, and connected to center of shaft by a small, flexible tube. The end of the shaft is bored out and is provided with a hollow steel tube free to revolve in the spindle and fitted with gland and stuffing-box nut to prevent leakage of oil. Connected with this steel tube is the stand S, carrying a pressure gauge and an indicator. When motion is given to the pulley L it revolves through a small arc until a steel pin in its arm comes in contact with the plunger in cylinder c. If there be no resistance to be overcome, the indicator pencil and gauge finger will remain at zero; but as soon as resistance be applied the plunger will be forced inwards. When the power overcomes the resistance, motion will be communicated to the pulley F, and the machine is driven through the force transmitted by the oil.

As the plunger is forced inwards, the indicator pencil and gauge finger will in consequence rise, and the amount of rise will determine the pressure per square inch acting on the plunger. If the distance of the lever arm acting on the plunger is known, the power can be readily ascertained from the following formula:

$$H\ P = \frac{P v}{550}$$ where P is the pressure in pounds, and v equals the velocity in feet per second; in terms of the number of revolutions per minute we have

$$H\ P = \frac{P \times 2\,\pi\, r\, N}{12 \times 60 \times 550} = \frac{P \times 2\,\pi\, r\, N}{12 \times 33{,}000}$$

in which r equals radius in inches of path traversed and N equals number of revolutions per minute. If the construction of the machine be such that r is constant, as in the present case, and equal to C, the formula becomes:

$$H.\ P. = \frac{P \times 2 \times 3.141592 \times C \times N}{12 \times 33{,}000} = 0.00001586\ P\ N\ C.$$

When r is variable its exact determination would be a difficult matter, but if this variation of arm be neglected the final result will be vitiated.

In the experimental machine constructed by the writer the pulleys were each 12 inches in diameter and 3½ inch face; the cylinders were 1.954 inches in diameter, presenting an area of 3 square inches. The plungers were of hard bronze and were kept tight by leather cup washers secured to the end; grooves in the plunger, as for water packing, and cast-iron piston rings were successively used, but abandoned after a short trial as not being trustworthy. A 5-lb. spring was used in the indicator (a Tabor) as with stronger springs the card obtained was not sufficiently large to show the delicate changes which it was desired to bring out. Instead of a piston having an area of 3 square inches, the results of experiments show that an area of 2 or even 1 inch would be more satisfactory.

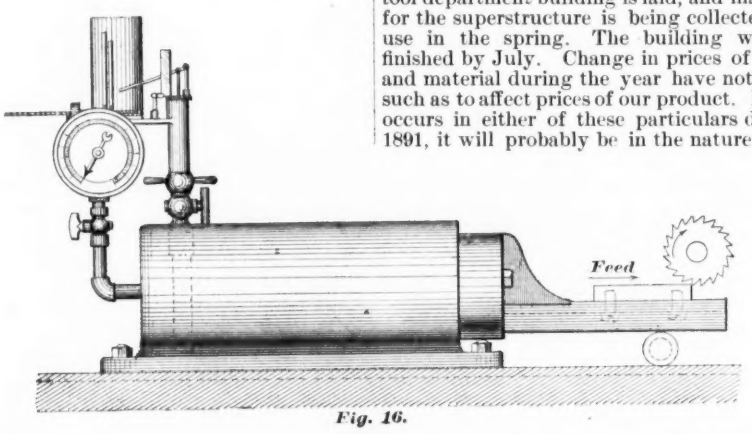


Fig. 16.

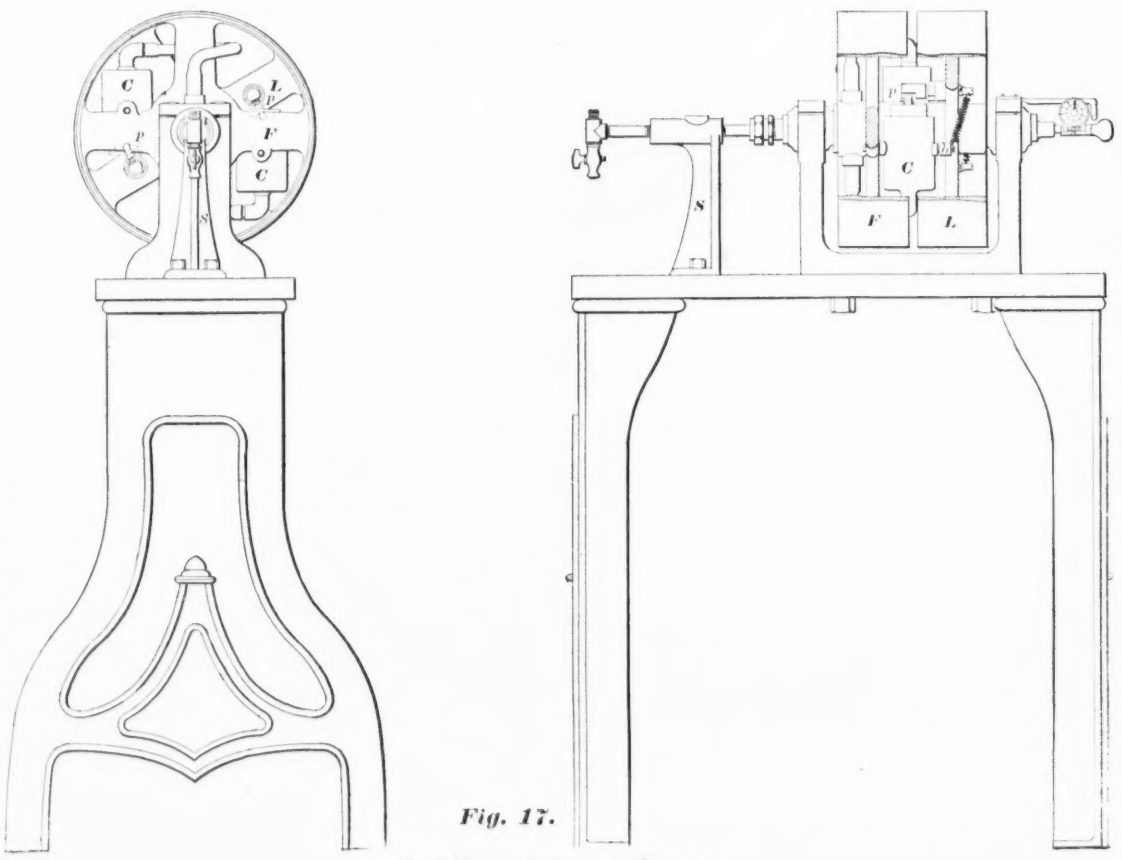


Fig. 17.

THE MEASUREMENT OF POWER.

Condition and Prospect of the Machinery Business.

LETTERS FROM PROMINENT ESTABLISHMENTS TO THE "AMERICAN MACHINIST."

The Pratt & Whitney Co. (Machinists' Tools, Forging and Finishing Machinery for Sewing Machine and Gun Manufacture, and Special Purposes, etc.), Hartford, Conn., write us:

We have the pleasure to state that our shipments during 1890 were 11 per cent. in value in excess of those in 1889. About 25 per cent. of the whole going abroad.

Unfilled orders are likely to keep us busily employed for the first three months of the new year. The foundation for our small tool department building is laid, and material for the superstructure is being collected for use in the spring. The building will be finished by July. Change in prices of labor and material during the year have not been such as to affect prices of our product. If any occurs in either of these particulars during 1891, it will probably be in the nature of a lighted shop. The roof is self-supported, being made of heavy timbers, well braced, arranged for carrying cranes, so that the heaviest work can be readily carried throughout the shop.

We are building a splendid line of self-contained, side-crank engines, and return-flue boilers, also the old reliable "James Leffel" double turbine water wheel of all sizes and styles, including high-grade wheels for mining and other purposes.

Our patterns are all new, of the best design and proportion that 25 years' experience in this line of trade could suggest.

As will be seen by cut in pamphlet, our engine is of a neat, simple, strong and substantial pattern, and is giving great satisfaction in the hands of our customers.

Our outlook for trade is especially bright, and we are pleased to say that our thorough equipment in our new plant, with machine tools of the latest and best design, especially made to produce our work, enables us to meet in the highest degree every demand of our trade.

To any one in need of steam power, we shall be glad to send our engine pamphlet, or to those about to improve water-power, we will take pleasure in sending our handsome new water wheel catalogue.

The Barr Pumping Engine Company, Philadelphia, Pa., write us:

We are pleased to report that business during the year 1890 has been fully up to our expectations; the demand for all kinds and sizes of pumping machinery has been good. We have made no additions to our buildings during the year, but we have added several machine tools to keep pace with our increasing business. We are now full of work, and have been running our large tools twenty-four hours a day for several weeks past. The outlook for the coming year seems to us very promising.

Heber Wells, successor to Vanderburgh, Wells & Co. (Printers' Materials), 8 Spruce street, near Nassau street, New York, writes us:

Following along in the steps of Vanderburgh, Wells & Co., the policy of the business has not as yet been changed enough to produce any marked results.

The great bulk of my transactions is with printers, and therefore not of interest to machinists.

The business is in about the same condition as a year ago, and for the future it is hard to say.

Williams, White & Co. (Forming and Forging Machines, Drop Hammers, Punch and Shears, Spring Power Hammers, Special Machinery, Eye Bolt Machines), Moline, Ill., write us:

We have had a very satisfactory business in 1890, sales having increased about 35 per cent. over any former year, and have been compelled to build a new shop, rather against our will, we must confess, but the old shop was so crowded that it was a case of necessity. The new shop is brick 70x206 feet, and a traveling crane through the center commanding a floor 32x206 feet, 22 feet high. Orders still keep up, and have no stock on hand.

Hilles & Jones Company (Machine Tools), Wilmington, Deleware, write us:

We have been exceptionally busy throughout the whole time. Our output has been considerably increased over the year before, and we have made quite extensive improvements, both in our shops and outfit of tools. We have completed an erecting shop 70 feet wide, and 153 feet long, which is equipped with a 20-ton traveling crane, and specially designed for the heavy class of machine tools of which we make a specialty.

We have also added considerably to our plant in new tools, among them being a planer to plane 10 feet wide, 7 feet high, and 30 feet long. Also an Acme bolt cutter and other tools.

In addition to these changes we have thoroughly equipped our plant with automatic sprinklers and fire service, so that our property, we think, is now as fully protected as is possible.

During most of the past year we have been running our works overtime, and have been unable to complete our orders in as short time as we desired. Our greatly improved facilities, however, put us in good shape for the coming year, and the prospects seem to

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Beaman & Smith (Machine Tools and Special Machinery), Providence, R. I., write us:

We have done a very satisfactory business during the last year. We have enlarged our works, also added several machine tools. We feel that the indications for business the coming year are favorable.

The Leffel Water Wheel and Engine Company (Manufacturers of The Old Reliable James Leffel Turbine Water Wheels, Steam Engines and Boilers), Springfield, Ohio, write us:

We have this year built entirely new shops, as shown by cut on back of engine pamphlet and water wheel catalogue that we mail you. These shops cover nearly two and one-half acres of ground, and are built with brick walls 19 feet high, covered with a slate roof, and ventilators as shown in cut, distance from floor to top of ventilator being 32 feet, making a large, airy and well-

be encouraging for a steady business during that time.

We have been building recently a large number of heavy punches, several of them being 4 feet in the gap, and capable of punching 1½ inch holes in 1¼ inch plate. Giving, as we do, the closest attention to our particular line of tools, we think we keep up to the best that are made, so far as durability and convenience in working are concerned.

Prices for material generally remain very near the same, while wages have advanced somewhat.

Crescent Steel Co., Pittsburgh, Pa., write us:

Our business during the past year has been good, and for the finer grades of steel prices have ruled pretty steady. The lower grades have been sold on a very small margin of profit, and there does not seem to be much chance of any advance in this respect.

Our trade being so largely with machinists and fine tool makers, who look more closely to good quality than low price, we notice an increase in the consumption of fine steel by those who used to think foreign material indispensable to their work, but who now know, of their own knowledge, that no better steel is made anywhere than at home.

Drill rods and self-hardened steel have gone into a good many shops where formerly a strong prejudice existed against American steel, and with the necessity for getting all the work possible out of a tool, there must be a fair demand in view for high grade steel, which must necessarily be made from high grade iron, which is expensive and not subject to the ordinary market fluctuations in cost price.

More buyers are calling for high carbon steel, and learning how to use it so as to get the increased service which it is capable of giving with proper treatment.

From the present outlook, we believe that next year will bring a good volume of business which will have to be taken on close margins of profit, with careful scrutiny of credits.

Sibley & Ware (Manufacturers of Shafting, Hangers, Power Drills, &c.), South Bend, Ind., write us:

We have had good business this year, and see no reason why 1891 will not be the same or better.

The Garvin Machine Company (Milling Machines, Drill Presses, Screw Machines, Hand Lathes, Cutter Grinders, Profilers, Tapping Machines, Gear Cutting, Index Drilling, Milling Cutters, etc.), New York, write us:

Our expectations of a year ago have been more than realized, in that last year's business exceeded the previous year's by a large amount. We considered that we had ample room for all our requirements, but increase in our business has compelled additions to our space over last year.

We are at present working on a new catalogue, which will show enlarged line of manufactures, principally in the completeness of turret head machinery. We have more help than ever before, and we anticipate and are preparing for a good steady business for the coming year.

Warner & Swasey (Machine Tools and Special Machinery), Cleveland, Ohio, write us:

During the year just closed our number of employes has been increased from 100 to 140, and the present business outlook points to a continued enlargement.

Nicholson & Waterman Manufacturing Company (Machine Tools), Providence, R. I., write us:

The output for the year just closed is nearly double that of the previous year. While we would have expected as a result of the monetary troubles of the close of the year a falling off of trade, and while in some instances this has been the case, yet at this time the outlook for business is the best we have experienced for a long time.

During the past year we have added many new tools to our line of production, and added materially to our facilities for handling work.

Wiley & Russell Manufacturing Company (Lightning and Green River Labor-saving Machinery and Tools), Greenfield, Mass., write us:

The past year has been a remarkably busy one, the demand having been much larger than ever before. We have much increased our capacity for production, nearly doubling our buildings and adding proportionately to machinery.

We have also largely increased our line of manufactures—taps, dies, reamers, and machinery, adding several new bolt cutters and pipe cutters to the patterns previously made, which are shown in the new price list now being issued.

Prices have remained about the same, and we see no great change in wages.

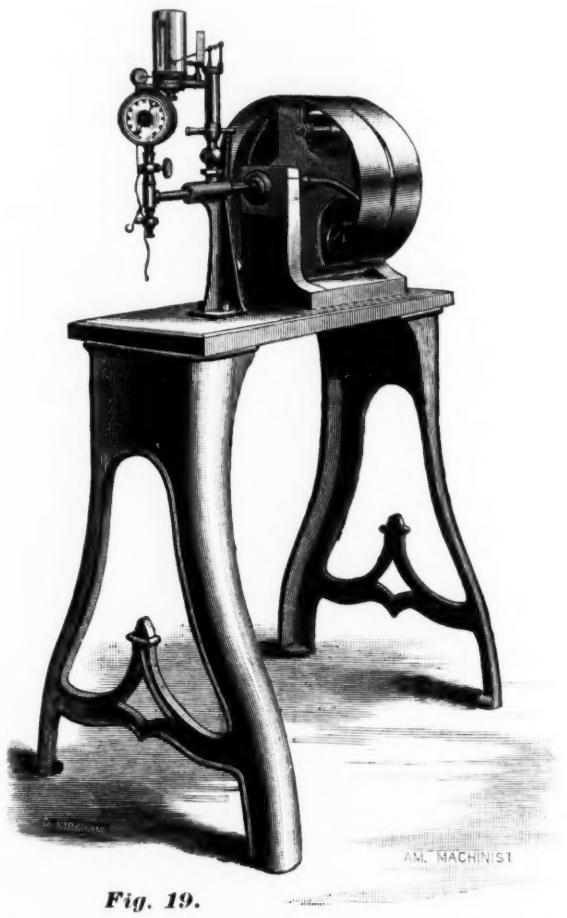


Fig. 19.

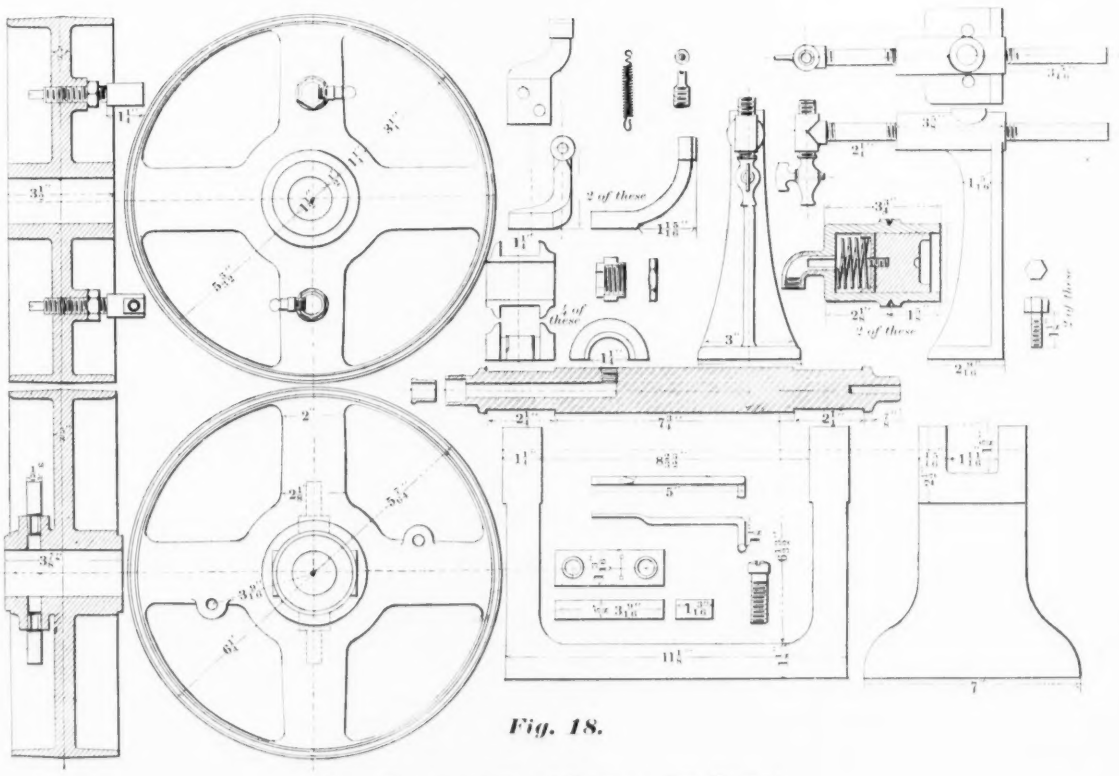


Fig. 18.

THE MEASUREMENT OF POWER.—SEE PAGE 4.

Jos. B. Reed (Engine Lathes), Cairo, Ill., writes us:

I am pleased to say that my business for the year ending January 1st, 1891, has been all that could be desired. I have had orders for tools booked from three to five months ahead during almost the entire twelve months. The outlook for the coming year is very encouraging indeed—so much so that I have purchased an adjoining lot 50x150 feet, and added a three-story addition to my shop 25x120 feet, in which I am placing several thousand dollars worth of new machinery, and which I expect to have all fitted up and in running order by February 1st. I am at present working on a number of improvements which I intend bringing out soon. With my additional shop room, increasing my manufacturing capacity nearly 50 per cent., I hope in a short time to have a stock of tools on hand to enable me to ship on receipt of order any reasonable demands.

The Universal Radial Drill Company ("Universal" and "Radial" Drilling Machinery), Cincinnati, Ohio, write us:

The year just closing has been the busiest we have ever had. Our increase of business has been very satisfactory to us. We have made revisions upon all of our standard machines, adding very materially to them in weight, increasing bearings, etc., and we have also improved our methods and product. We have increased our plant and machine tools about 30 per cent., and you will note by circular below that we will take up another line of tools, viz., engine lathes. Wages have advanced nearly 10 per cent.

CIRCULAR.

For the purpose of making more room for our planer business, which we intend to reduce to a still more perfect system, and prosecute as a specialty, and in accordance with a previous agreement with you, we have delivered all drawings, patterns, special tools and fixtures which have been used by us in the manufacture of our 17-inch and 20-inch swing engine lathes. We have also licensed you to use all patented improvements as used by us in the manufacture of these lathes.

In making this transfer we have constituted you as our successor in the manufacture and sale of these two sizes of lathes, and believe you will have the same success and patronage that we have enjoyed since these tools have been known in the market. Respectfully yours, THE G. A. GRAY CO.,
G. A. GRAY, Prest.

J. Wyke & Co. (Fine and Improved Machinists' Tools), East Boston, Mass., write us:

Business has been very good with us, and has been so constantly increasing that we have just about doubled it in the last three years.

During the present year (1891) we expect to put on the market several new tools (secured by patent), and have every reason to believe that this will be a very prosperous year with us. The demand for our "universal screw cutting, center, depth, angle and twist drill gauge" is constantly increasing, and we are shipping them to almost every part of the world where machinists are employed. This, we believe, is due not only to the great merits of the tool itself, but also to the wide circulation of our advertisement in the AMERICAN MACHINIST.

Hill, Clarke & Co. (Dealers in Machinery), Boston, Mass., write us:

In regard to the condition of the machine tool business during the year 1890 would say that it has been the best year we have seen in our business, with the exception of the year 1882. Nearly all the shops whose tools we control are sold ahead for three months of the coming year.

J. Stevens Arms and Tool Company (Guns and Machinists' Tools), Chicopee Falls, Mass., write us:

The J. J. Stevens Arms and Tool Company expect to have the large addition which they have made to their works, ready by the first of the year, which will greatly increase their facilities for turning out work. The company are making preparations to double their business another year, although the present year has gone ahead of all previous ones. Their business outlook never was brighter than at the present time for a large business the coming season.

S. M. York (Machinery and Engineering Machines and Specialties), Cleveland, O., writes us:

We are pleased to announce that our business for the year 1890 has been exceptionally good, having increased very largely both in our store and shops. We consider the outlook for 1891 as very good. In our manufacturing department, known as the American Tool Works, the demand for our specialties has steadily increased, and we have lately added some new specialties to our line which we think will aid materially in increasing our output for the coming year.

James H. Wells (Machinery, Steamboat and Mill Supplies, and Repairs), Tampa, Fla., writes us:

My business has steadily increased during the year, so that I am now crowded with work, making shafting straighteners, phosphate machinery, saw-mill, steamboat and electric light work. I have built a shop 40x96 feet, two-story, with outbuildings, and shall move in in a few days; my prospects are excellent.

Nicholson File Company, Providence, R. I., write us:

Our business for 1890 has been exceptionally good, prices remaining very low but steady throughout the year.

We have not been able to discover any tendency to speculate by our purchasers, and on the whole we see little reason why a good steady business should not be looked for during 1891.

We have enlarged our plant by the erection of a new brick forge shop, 40x262 feet, and remodeled and enlarged several of our other departments considerably. The effect of this will be to give a larger output, and enable us at an early day to fill our orders more promptly, both in our (X F) brands as well as the regular or Nicholson files.

The New American File Co.'s plant and

machinery of Pawtucket, R. I., having been recently purchased by us, is being remodeled and put into condition to turn out the heavier and coarser grades of files of this brand of good quality, and at low prices.

R. M. Clough (Duplex Gear Cutters, &c.), Meriden, Conn., writes us :

In answer to yours of the 10th will say business with me for the year has been good, with prospects of plenty of work for 1891. I am expecting to put in more tools soon, so as to give facilities for getting out special gear cutter work promptly as possible. My sales of duplex gear cutters have far exceeded my expectation this year. I think it pays to be honorable in business transactions and to advertise rather liberally.

Samuel C. Rogers & Co. (Grinding Machinery, Emery and Corundum Wheels, etc.) Buffalo, N. Y., write us :

Business with us for the past year has been fully up to our expectation. We have more than doubled our plant, and are even now somewhat behind on orders. The amount of business done this year will be more than double that of last, but we credit advertising, and the fact that our specialties are becoming better known, more than any general improvement in business, with the increase. This city is noted for its low wages, and as our land boomers have not been able to get up a boom of exceeding "*boomth*," they are not liable to be forced up by high rents. Prospects for next year are encouraging.

Geo. D. Walcott & Son (Machine Tools, Gear and Rack Cutting to Order), Jackson, Mich., write us :

The year 1890 has been a very satisfactory one to us. Our business has shown a gradual increase from year to year, and we look for a good business for 1891. During the last year we have built an addition to our shop, so that we now have about double the room. Have also put in a number of new tools, and have arrangements made for others to be put in soon. All of our tools are now built from entirely new and improved patterns, and have added two new sizes of shapers and one new size of lathe to our line. We find little or no change in the price of labor, product or material.

S. W. Lord & Co. (Boiler Cleansing Compound), Philadelphia, Pa., write us :

During the year just ending we have we feel sure received a flattering share of the patronage of American steam users using boiler cleansing compound. At the Piedmont Exposition at Atlanta, Ga., held in October, we were awarded the first premium medal for the excellence of our compound. In the early part of the year we established a branch office at Baltimore, and the result has been so encouraging that we feel now justified in opening an office and store in Chicago, which we hope to get established in January. Altogether, in looking back over the year 1890 we are satisfied, and feel confident that the coming year will be to us one of prosperity.

I. P. Richards (Punches and Dies for Punching Iron and Steel), Providence, R. I., writes us :

We have furnished to boiler makers, bridge builders, and others more punches and dies the past year than ever before, and are constantly making improvements in order to turn out better tools.

I have a new shearing punch which I intend to place upon the market soon, which will be valuable for punching large holes.

What has troubled me the most has been to find steel just right for punches, which will also hold to the same uniform *quality* year after year forever.

I return the compliments of the season to the *best* mechanical paper on earth.

LETTERS FROM PRACTICAL MEN.

More About Center Indicators.

Editor American Machinist :

In order to locate holes accurately by the use of the center indicator we have first to locate the centers, and this sometimes is very difficult to do accurately.

For this reason, in a great many cases on jig work a button is screwed on and located, and then trued with the outside indicator. In some cases we can avoid the use of the button, and still do accurate work.

In building milling machines sometimes the yoke that is used to support the outer end of milling arbor is bored to fit the big bar, and the sides of hub squared true; then it is put in place on the machine, and with a true hardened center in the spindle, a center mark is made on the yoke that is accurate. so in this case the center indicator can be used with good results.

In some cases the little contrivance shown in Fig. 1 can be used to help in laying out holes accurately. This is just a little hub with a nice straight hole, and the outside turned to some standard size, preferably 1″, and the little center punch with the center ground true with the body, and a nice fit in the hole. Now, on a job that will admit of it, we can hold this down on the work, and locate it by measurements to its outside (always deducting its radius from our dimension). Where this can be used it will be found much more accurate than drawing lines and locating our centers at the intersection of these lines by the common plan. I give this for what it is worth —for work that will admit of its use—not for a purpose where some other plan would be better. It is by knowing a great many schemes for doing work that we are able to choose the best for the work as it comes. If we can pick our work we can pick our tools, but some are not so fortunate.

The center indicator for drill presses I gave a few weeks ago, not, as it seems that Mr. Beach understood, as *the* way to drill or bore a hole accurately, but as *a* way when something better cannot be found. The plan Mr. Beach speaks of I have found to be a very good one where it will apply, but, unlike Mr. Beach, I have found a great many cases where it would not apply.

Sometimes we have to locate holes on a curve, and sometimes on a steep incline; sometimes on a very rough surface, and sometimes in places where we would be at our wits' ends to find some way to clamp the temporary jig, unless we could use gravity or magnetism to hold it. In a great many cases the difficulty is in another way, that I will try to describe by the help of Fig. 2.

We will suppose the work shown is a heavy casting (say 200 pounds, or that it is such shape as to compel us to clamp it down), and it is wanted to make a nice reamed $\frac{7}{16}$″ hole square through (square with the bottom). Now, if the work was light, and was not clamped down, the drill would center it, and would keep there; the only thing that would make it run off after starting would be soft places, or some fault in the material. In the case shown, the work being heavy and the drill weak, the laid-out hole is not got under the center of spindle, and no matter if we do start the hole where it is laid out by using a jig or anything else, it will not come out where we want it (unless it is accidental). Of course the case I show is much magnified, for most machinists in such a case would use the center in the spindle, and bring that down to the work, and so could see when it was near central; but when we speak of accuracy we want some other plan than this, and I don't know of a better one than the center indicator I gave. If Mr. Beach has a better plan for this purpose he would do me a favor, and I think a great many of the readers of the AMERICAN MACHINIST, if he would give it.

When the center indicator is used in a case like this, and the hole bored a very little way (say $\frac{1}{4}$″), by use of the single-pointed cutter. (An independent chuck, and a piece of Stubbs' wire, with a boring-tool point turned on it, do for a boring rig sometimes, if there is nothing better. The cut can be adjusted by screwing the jaws.) To start a rose-bit central, then, this little bored place will confine that bit to a straight line, and we can plan on coming out about where we want to.

I have seen a man, when starting to do such a job, rig an arm on the spindle to sweep around the outer part of table, and so find where the table was lowest, then get a jack screw and set it under this side and screw it up till the sweep would touch almost all around. In clamping the work upon a knee, great caution was used to see that the knee was just square, and that no dirt got in anywhere in "rigging up," then after boring the hole find that it was *way off*.

This error was laid to some "stag hole" in the casting, but when the truth is known the trouble will be found as is shown in Fig. 2.

A MECHANIC.

An Improvised Boring Mill.

Editor American Machinist :

I was very much interested in Mr. Rogers' description of the manner in which the large pulley was finished with improvised tools. Then Bell Crank's description of pulley boring without proper tools, by an Ohio machinist, set me thinking that perhaps another—and, to me, new—kink in the same line might be in order.

A few days since, while erecting the machinery of an electric lighting plant in a small Michigan city, it was discovered after the dynamos were in place that a drive pulley 50″ diameter by 12″ face, with hub eight inches in length was bored to exactly $2\frac{7}{8}$″, while the line shaft on which it was to be placed was precisely three inches in diameter. Here was a dilemma. No time in which to get another pulley from the contractor's shop, and the only shop in the town—a small "cheese-box" sort of affair—

Fig. 1.

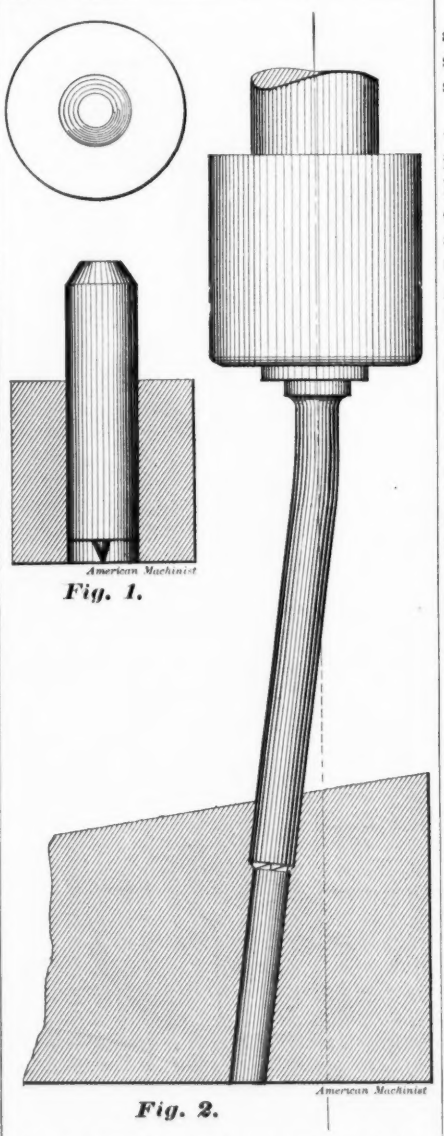


Fig. 2.

the whole machine tool equipment of which consisted of a 25″ swing lathe, a 28″x28″x8 foot planer, and a 28″ drill press. Everything was rushing; contractor's time almost up; no time to send pulley to outside shop. So the "Old Man" of the little shop was consulted. The Ohio machinist was not working in the Old Man's shop, and he had not read Bell Crank's article in the AMERICAN MACHINIST, but he told the expert in charge to send along the pulley. The pulley came. The Old Man fished a piece of $3\frac{1}{4}$″ shafting about 30″ long from underneath the bench in the corner, and, after centering, placed it in the lathe. He then turned it to three inches in diameter for two-thirds its length, leaving the remainder of shaft full size. Then commencing at the small end of shaft he turned it to fit the bore of the pulley for a distance of 10″ from the end. After finishing this to suit, he proceeded to drill a one-half inch hole through the center of shaft about $8\frac{1}{2}$″ from small end. In this he fitted a small boring tool, which he forged at a neighboring blacksmith shop. This tool was forged from a piece of square tool steel, and was fitted in by driving, the corners of the tool cutting into the softer iron of the shaft, holding it securely. The side of the tool next to the small end of shaft was placed at an obtuse angle with the centers of the shaft to give the necessary clearance. The end of tool was then ground so as to leave it projecting just $\frac{1}{16}$″ from the surface of shaft. The shaft was then clamped, tool side up, to the planer bed, under a pulley on line shaft, leaving the small end projecting over edge of bed. The pulley to be bored was placed upon the projecting end of shaft, and brought up against the cutting edge of the tool. A piece of two-inch belting connected the pulley on line shaft with pulley to be bored. The engine was then set to running slowly. A piece of 8″x8″ timber two feet long, with one end resting on the floor, and one edge against the pulley rim, and backed by a stout cub sitting on a broken cylinder, formed the feed works of this boring rig, and the result was a good job in a limited time.

BERT LEDALEY.

The Schiele Curve.

Editor American Machinist :

I notice in your issue of January 1, 1891, a sketch of an end bearing for a vertical shaft, designed by Mr. Arthur Lane, which seems to invite a few remarks.

As this bearing carries but 3,000 pounds weight, on a cross-sectional area of 28 square inches, or 104 pounds per square inch, very likely it will run if Mr. Lane can find any one willing to bear the cost of construction, and also a millwright who can set it up with the necessary accuracy, and, after that, some good way of keeping the oil-holes clear; but the result obtained seems very small when we remember that a mill-stone weighing a ton frequently bears its whole weight upon the flat end of a hard steel pivot $1\frac{1}{2}$″ diameter, or one square inch area of bearing. I think Mr. Lane could do far better using an end bearing about four inches diameter, or larger if he wants to, but made of the form of the segment of a sphere about one-half inch height.

The die or fixed bearing should be dished to fit the pivot. This form gives a chance for the bearing to adjust itself, which it does not have when made flat, or when made with the Schiele curve.

If a side bearing is necessary it can be arranged further up the shaft.

The pivot and die should be of steel, hardened; cross gutters should be in the die to allow oil to flow, and a central oil-hole should be made in the shaft.

The anti-friction pivot of Schiele, with all the sublime nonsense which has been written about it, has become one of our engineering classics, and is very likely to remain so, as the makers of mechanical books, knowing nothing of mechanical facts, are content to arrange and rearrange whatever they may see in current print which is usually advertisement.

Schiele was a mechanical crank who flourished in Manchester, England, about forty years ago. He made his mark on the patent records of that country with rotary engines, and other schemes, among them his conical mill, which was boomed at the World's Fair of 1852. There was a fetching argument to prove that the form for the mill (which we want to have grind fast) was equally well suited for the step (which we do not want to have grind at all); that is, his magic curve which he had patented was a friction curve when used for shaping mill-stones, and an anti-friction curve when used on a step.

His exhibit was reported on by learned professors, notably one Dr. Peacock, who spread himself in this wise. "* * * It is one of those singular and beautiful curves called tractories." "* * * The mechanical tractory of a straight line upon a perfectly smooth plane is an inverted semi-cycloid, but in this case the retardation produced by the pen and paper causes the curve to be infinite, and from its peculiar properties it has been termed the *equitangential tractory*. * * *"

Small wonder is it that, after such a description, Schiele's curve passed into the dictionaries, there to remain for the enlightenment of young searchers after the truth.

WILLIAM H. HARRISON.

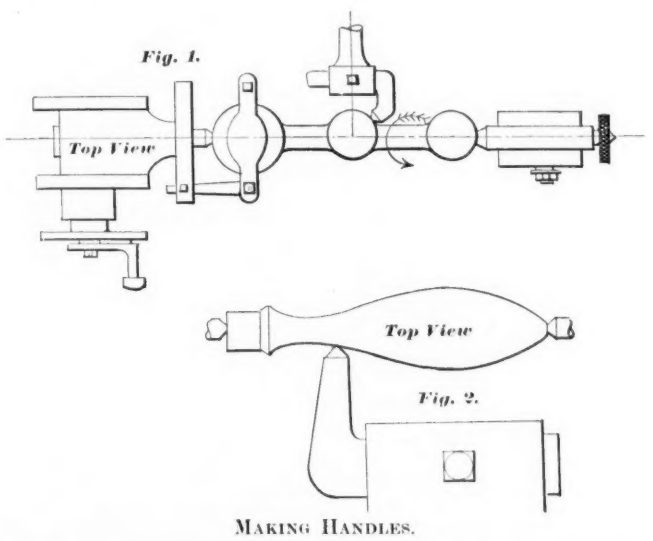
Making Handles on the Milling Machine—Slotting Valve Yokes.

Editor American Machinist:

Peter Shellenback's handle drilling fixture, described in the issue of Nov. 13, suggests the idea of performing the same operation in the universal milling machine, and, in addition thereto, that of turning the ball. This is not offered as any particular improvement in the operation of turning and finishing handles, but merely to show a train of thought, and an interesting milling operation.

I send you drawing of a scheme for slotting two or more valve yokes at a time on the slotter. The angle iron or holder is the essential point. This should be planed with grooves for each stem, holding them parallel with the table; as this form of valve yoke is quite general, time can be saved and more uniform work produced. This device is in use at the B. & M. R. R. shop, Plattsmouth, Neb.

L. C. SHARP.



MAKING HANDLES.

The Duties of a Locomotive Fireman.

Editor American Machinist:

I suppose every young fireman considers it his first duty to keep up plenty of steam; and his next important one to keep his engine clean. These certainly are his most important duties. But these are not all, if he is studying to be an engineer, and a good railroad man. He must study the character of his engineer, find out what kind of a man he is; ascertain his likes and dislikes, and study to please him. If he is not interested in sporting matters, don't keep telling him the score in base ball, or which man won in the boat race, but let your conversation be of interest to him, so that, when you ask him in regard to the engine or railroading, he will be interested in you.

There is perhaps but one right way to clean an engine; but they are cleaned in many ways, according as the fireman feels, or the master mechanic compels. But if your engineer is a neat and clean man, and likes to see things kept to correspond with himself, you should clean the engine to suit him—that is, keep your front end black, keep your jacket free from grease and oil, shine up your bell and bright pipes, and the other ornaments, which to-day are few as compared with engines a few years ago. Keep the windows washed in the cab, and keep the cab washed out. It is much easier to wash out a cab once a week, with hot water and soap, than it is to let it go, and then have to scour it out. Clean the brass in the cab, and keep the oil cans nicely wiped; but above keeping them clean, always be sure they are full of oil. Always come to work the first of the week with clean jumper and overalls; although they don't keep clean long, yet it will let your superiors see that you are neat in this respect.

Then of your firing; if your engine don't steam well, and your engineer offers some idea how to fire her, just do as he says; not answer back, or keep at your old way. Then if she does no better, you can quietly, but not "out loud," have the laugh on him. But an engineer will not tell his fireman to do anything, unless he thinks it for the best.

Some fireman may think this is not very good, etc., and say, "never mind the little things; as long as I keep plenty of steam on, and keep her up to blowing-off point, and keep her wiped, that is all that is needed." But it is the "little things" from which he will form his opinion of you. And when the master mechanic asks him what kind of a man you are, if you have been particular, he will say, "first-rate," but if you have neglected these little things, he will say, "a good fireman, but a little careless." We all know it is the little things in life that count. A little switch is wrong, and your engine is on the ground, with one or two cars on top of it. A little oil hole neglected, and a hot box or pin results.

It is an important duty of a fireman to find out how his engine is constructed, and if broken, how repaired. Ask your engineer, and if he can't tell you, ask some one that can. Then study some book on the locomotive. Supposing your engineer can't tell you about the engine, and you find out elsewhere, don't think you know it all, or more than he, because a man may be a very good engineer, and still be ignorant of the "whys" and "wherefores."

There are many qualifications that go to make an engineer, and understanding these "fine points" are only a few of his duties and responsibilities. If he can keep clear of everything on the road, and run without accident, due to his carelessness, although he may not understand the engine perfectly, I consider him a better engineer than one that causes a wreck, even if he understands the engine perfectly. So a fireman must be humble, be a man, with all the word implies.

I fully realize how difficult it is to suit some men. Nothing ever goes right with them, but with such a man, be patient, and you will be repaid in the end, because he can have nothing against you.

BLOOMFIELD.

Making Castings Direct from the Blast Furnace.

Editor American Machinist:

It seems to me strange that many foundries in this country have to pay for melting their iron in a cupola when there is a blast furnace not twenty yards away. It is just as easy to make a runner from the main runner to the casting (providing it is low enough) as it is to cast it with a ladle.

I have read the account of the travels of those ironmasters from the old countries with interest, and the discussions pro and con relative to the merits of the way of working in the steel and iron works or mills between this and the old countries. Much has been said about the foundries.

It may be interesting to some molders to know that they used to cast molds direct from the blast furnace thirty-four years ago that I know of; either open sand plates or covered work.

The furnace that I worked at for about five or six years was one of the old-fashioned square ones, cold blast. It had been in blast at that time about eighteen years, and appeared good enough for eighteen years more. We used to take on an average from that furnace thirty or forty tons per day. We made one casting that weighed fifty-seven tons from it. It is a good way to cast a heavy piece, as all you have to do is to make up your runner and let the iron run into it. I do not think with the blast furnaces that we have in these days there would be much trouble in making a casting 75 or 100 tons if necessary.

I remember one furnace that I worked at when we could not tell one day from the other what kind of iron we were going to get, as during the night it would *scour*, as we called it, from nice gray iron to white close iron. But we could very easily tell by looking at the slag or cinder. If the slag was black it was white iron; if gray, it was soft iron.

Some may object to having castings made direct from the blast furnace, thinking that the iron ought to be melted over again to make good castings. But I have seen as nice and clean castings come from the blast furnace as ever came from any foundry.

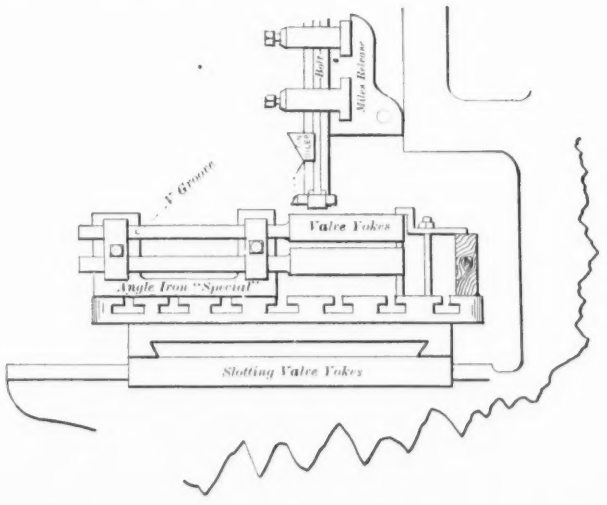
There is a variety of work that could be made a specialty at a blast furnace, such as yokes and manhole covers for cable roads, large size water pipes, furnace plates for rolling-mill or steel works, flooring plates, and a variety of other castings for iron works that are cast in flasks, that would answer their purpose just as well if they were cast open.

THOS. WATHEY.

Notes on Fly Wheels.

Editor American Machinist:

In connection with Question 449, current volume, perhaps the following method of calculation of fly wheel stresses will be of interest:



To find the tension in one section of the rim due to centrifugal force alone, and regardless of the arms, use the formula

$$P = \frac{W R N^2}{18{,}450}$$ where

P represents the tension sought in lbs.

W represents the total weight of rim in lbs.

R represents half the mean diameter of rim in feet.

N represents revolutions per minute.

Applying this in the example given,

$$P = \frac{3{,}960 \times 6{,}645 \times 3{,}600}{18{,}450} = 5{,}134.$$

This result is a little more exact than that found in the example referred to, although either is sufficiently close.

In high speed engine practice the influence of the weight of half the rim in increasing this tension is so small in proportion to the centrifugal tension that it may usually be neglected.

Bolts or links which are used to fasten together the parts of a sectional or divided rim should be designed to safely hold the whole tension as found above, regardless of the arms. The factor of safety should not be less than 8 or 10. No part of an engine demands more care in its design, material and construction than these fly wheel fastenings, as shown by the many disastrous failures.

F. G. H.

Too Many Pieces.

Editor American Machinist:

Some machinery designers seem to carry the old saying of making "two blades of grass grow where one grew before" into machinery design, and use two or more pieces where one might do. I am led to this reflection by that mechanical canebrake, the engines for the new gunboat "Concord," shown in your paper of the 18th December.

It seems to me that the very smallest shot the enemy would be likely to fire would, if passing through this dense jungle, hurt something, or get hurt.

Again, suppose the machinery so well protected with armor that no hostile shot would ever reach it, there remains the liability of the failure of some of those delicate internal parts—and such failures generally take place just when they are not wanted, like a boil, always coming in a mighty bad place—and what a hurrying and scurrying there would be to tear down the surrounding complexity to get at the failure!

Of course, I don't know much about engines—or anything else for that matter—but it seems to me that a good triple expansion engine should be built with about one-tenth the number of pieces.

BENJ. F. WILSON.

High and Low Locomotives.

Occasionally the question of high or low locomotives comes to the front, and receives a due share of discussion. Recently, London *Engineer*, having quoted the veteran engineer D. K. Clark, as advocating a low center of gravity, Mr. Clark writes to that journal as follows:

"You take me a little by surprise in saying that I advocated a low center of gravity. I have searched in vain for the quotations you made, but I will ask you to make the following quotation from *Railway Machinery*, page 187:

"'*Height of the center of gravity, and the center line of traction.*—Though it is proper to keep down the mass of the machine as far as convenient, the height of the center of gravity is practically a matter of minor importance. We have found high-pitched engines to run very steadily, showing no peculiar susceptibility to roll, even with inside bearings only; so much depends for stability on other and entirely different conditions. Indentations of the boiler to clear the axles and the machinery, or the removal of the driving axle together to the rear, with the object of lowering the boiler, are expedients which we regard with indifference, and they can only be viewed as imperfect remedies for what may otherwise be efficiently prevented.'

"The drift of this extract is, I think, that I was in favor of high-set locomotives at least as much as of low-set locomotives, aud it harmonizes exactly with Rankine and McConnell's report on the locomotives of 1862, wherein they say, as quoted in your leader, that 'the locomotive engineer of the present day does not hesitate to place the weight of his engine as high as may be required for convenient arrangement of the parts.'

"It appears to me that, in spirit, Rankine and McConnell in 1862 were in precise accord with me in 1855."

A press dispatch announces that Prof. Rogers, who was prominently identified with the work carried on by Pratt & Whitney in the development of means of exact measurement, has, with Prof. Morley, of Cleveland, succeeded in measuring changes of length in a bar of metal caused by changes of temperature, to the millionth part of an inch. The experiments were carried on at Waterville, Me., in the laboratory of Colby University, and the principle employed was by the employment of light; the wave lengths of which were measured.

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English Opinion of Us.

The British iron and steel men who visited this country during the fall have been pretty extensively interviewed at home upon the subject of their impressions of this country, and, to judge from what we find in our foreign contemporaries, have expressed their opinions quite freely. Next to being able to "see oursels as ithers see us," is to know how others see us, and consequently it is interesting to know what impression of us and of our work was created upon the minds of our English and German cousins, by what they saw here.

The opinion which, above all others, seems to be most unanimously held by them is that we in this country pay more attention to devising labor-saving and automatic machinery, and yet that what work is done here by manual labor is done at a much more rapid pace, and by the putting forth of much more effort than is the case on the other side. Scarcely a man among the eminent iron and steel manufacturers and engineers fails to refer to this, and it agrees with what one will be told who talks on the subject with most Englishmen who have worked in the shops of both countries. It is difficult to find any other reason for this than that, this being a comparatively new country, in which development is going forward very rapidly, there are more chances for advancement, and for a man to improve his condition, and therefore more stimulus for ambition. Mr. Siddell, of Sheffield, for instance, gave it as his opinion that American workmen in iron works seemed "to be very hard working," and that they "do a deal more work than the Englishmen for their money." He also thought there was less drinking among the workmen here. He thought that men who possessed the necessary ability and perseverance could do better here than in England, but that they would have to work harder, and this seems to practically agree with the almost unanimous opinion. Mr. Fearnehough, of Sheffield, said, "I never saw men work so hard as they do in America, or have such long hours."

The making of cold rolled shafting at Pittsburgh seemed to attract some of the visitors, and one man (Mr. B. G. Wood, of the Wardsend Steel Co., Sheffield,) thought the work could not be so well or so cheaply done in England.

Sir John Jenkins was especially impressed with the ingenious contrivances seen here for economizing labor, and did not think trades unions exerted as much influence here, nor that there was as much effort to limit production upon the part of the men, but rather a spirit of rivalry between the men of different shops as to which could turn out most work.

The opinion was expressed also that a great deal of capital is being injudiciously invested here, especially in the South, where in some cases it seemed to be the object rather to get immediate returns than to so put down plants as to make permanent paying establishments. Whatever ground there may be for this criticism will be found, we think, however, in the demands made upon the engineer in this country by investors. As a general thing, immediate returns are looked for, and, unless promised, investments will usually be made elsewhere. One man seemed to have gained the impression that most of the best mechanics here, and those who occupied the leading positions in our industrial establishments, were Englishmen, an impression which we find it difficult to account for, and which, in our opinion, is entirely erroneous.

The Broadway Tunnel.

Now that Broadway is to be torn up in the spring for the purpose of putting in a cable railway, and to be also repaved entire, it is being suggested that the work go a little further and include a tunnel through which rapid transit trains may run, and the numerous underground pipes be laid.

It is being made apparent, we think, that the final location and character of the rapid transit facilities of which the city stands so much in need will not be settled so much in accordance with engineering principles, or with business considerations, as upon politics influenced by the several, or rather numerous "pulls," and influence of those who, in some way or another, expect to make money by having the road located in a certain place rather than elsewhere. The conflicting interests of real estate owners are a powerful influence in the struggle, and these interests do, and no doubt will use the politicians as their tools.

But so far as a subway for pipes is concerned, this is a much more simple matter. There can be but one location for a subway for the Broadway underground pipes, and that is through Broadway, and there will be little chance for controversy as to its character. As we pointed out years ago, such a tunnel must eventually be built; it is the only practical solution of the difficulty, and the sooner it is put in, the less it will cost to do the work, and the less money will be wasted in futile attempts to construct and maintain good pavements. It is an absolute impossibility to keep a street well paved which must be ripped up as frequently as the principal streets of this city are, and the new pavement which is to be put down in Broadway in the spring will very quickly be made no better than the present one, unless things can be so arranged that it can be not only well laid, but allowed to stay down somewhat longer than a week at least, after it is laid.

Most of our readers probably know a good deal about the ordinary spirit level, and that it is an instrument the use of which is to get things level and plumb. A new kind of spirit level seems to have been invented in the West, the probable effect of which will be to occasionally get things out of level, and out of plumb. The level is not a very accurate affair, we should judge, for it consists essentially of a pasteboard box with a bottle inside, the bottle containing the spirits and air bubble, which make it a spirit level. No adjusting screws or other refinements are provided, and the "glass" is quite large compared with other spirit levels, and is closed with a cork, so that the amount of spirits within may be reduced whenever it is thought that the level will work better with less. Any kind of spirits desired may be had, and it is expected that the level will find its chief market in the prohibition States.

Colonel W. H. Paine, the well-known civil engineer of this city, died suddenly at Cleveland, December 31. Colonel Paine won distinction and his military title during the civil war, in which he served as an engineer. He afterwards took a prominent part in the engineering work connected with the New York and Brooklyn bridge, and designed the cable plant for the railways, including the grip apparatus for the cars. His work of late has been almost entirely in connection with cable railways, he having designed and superintended their construction in many of the large cities of the country. He was engaged in superintending the building of such a road in Cleveland at the time of his death, and it is the opinion of some that overwork upon this hastened his death, though he had been known to be somewhat out of health for some time.

Literary Notes.

INCANDESCENT ELECTRIC LIGHTING. A Practical Description of the Edison System. By L. H. Latimer. To which is added the Design and Operation of Incandescent Stations, by C. J. Field, and a paper on the Maximum Efficiency of Incandescent Lamps, by John W. Howell.

In these days of electric lighting the science of electricity has become an all-important subject to many mechanics. For those who seek a general knowledge of the art of electric lighting by incandescence, the appearance of this little volume is timely; much valuable information can be gained from it. The subject is handled in a popular manner, and although no attempt has been made to embrace the alpha and omega of the science, sufficient is given to understand the general construction of plants for electric lighting, and a study of this volume will probably induce a deeper inquiry into the subject. The value of the book would have been much enhanced if an index had been added. Yet on the whole it is an excellent little book, and we can recommend it to all practical men. It is published by D. Van Nostrand Company, 23 Murray and 27 Warren street, New York. Price, 50 cents.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(22) G. H. P., Lynn, Mass., asks: Can you give me a rule for calculating the size of air-pumps for condensing engines? The pumps are to be connected direct to engine. *A.*—See answer to Question 226, in our issue of May 23, 1889.

(23) A. E. R., ——, asks: 1. How many trips has the "City of Paris" made? *A.*—We do not know. You can undoubtedly find out by inquiring at the company's office. 2. Did she break down on her first trip, or when? *A.*—The bad break of the "City of Paris" was after she had made a number of trips. Just how many we cannot say.

(24) G. T. C., ——, asks: Has copper been successfully tempered or hardened, and if so by whom? *A.*—There is a rumor that some one has recently discovered a process of hardening copper, but we do not believe it. It is also claimed that one of the "lost arts" is that of hardening copper, but we are equally skeptical in regard to this.

(25) C. R., ——, asks: Will you kindly inform me if there is any way by which I can harden brass? I have some pointed pieces which I would like to harden, but do not know of any way by which to harden them. *A.*—So far as we know, there is no practical way of hardening brass except by rolling or hammering it; these and analogous processes having that effect to some extent.

(26) A. G., Dayton, Ohio, writes: I have seen the following formula, given for finding the centrifugal force of rope used in the transmission of power. $F = \frac{P \times v^2}{g}$, where F denotes the centrifugal force; P, the weight of one foot of rope in pounds, and v, the velocity in feet per second. Has the writer any right to leave the radius of the pulleys out of the calculations? *A.*—The foregoing formula is correct for the tension due to centrifugal force in a rope. Hence, F denotes tension, g, of course, denotes the acceleration due to gravity.

(27) R. H., ——, writes: I wish to make models for "Blanchard" lathe in great numbers, a sample of the form of which I send you by mail. The piece turned : model : : three : four. The model, or pattern, is 33 inches long. My object is to produce patterns as cheaply as possible, durability and accuracy being considered. Patterns are of cast-iron, and are ground and milled to shape. *A.*—You can harden such pieces after being formed by heating them to a cherry red, applying potash and dipping them into water. You may lose one occasionally by springing, but, with reasonable care and avoidance of overheating, the loss will probably not be great.

(28) G. F. W., ——, asks: Will you tell how to figure the thickness of teeth of bevel gears at small and large ends of teeth (at pitch line), say 8 pitch, 24 and 48 teeth? *A.*—The thickness of the tooth at the outside pitch line is the same as for spur gears, and the thickness is determined in the same way, *i. e.*, $\frac{1.57}{P}$. In the case of your 8-pitch gears, this gives for the thickness at the outside pitch line $\frac{1.57}{8} = .196''$. The thickness at the inside depends upon the proportion which the width of face bears to the length of one side of the pitch cone. Practically, it is most convenient to lay this off on paper to determine the proportion. If, for instance, the width of face is found to be one-third the length of the side of the pitch cone, then the thickness of the tooth inside will be one-third less than its thickness outside, and, in the case given by you, would be .131″.

(29) W. O., ——, sends a rule for finding the diameter of a gear wheel, and wishes to know if it is correct, and, if not, then he asks for one that is correct. The rule is evi-

dently not quoted correctly by W. O., because as quoted it has no meaning, but from the example worked out we should suppose the rule to be as follows: Reduce the pitch to 32ds of an inch, multiply by the number of teeth in the wheel, and divide by 100; the result will be the diameter in inches. The rule gives results, so far as we have tried it, which are close approximations to those given by the regular rule, *i. e.*, multiply the pitch by the number of teeth, and divide by 3.1416. The rule given for thickness of tooth is for cast gears only, and is all right for ordinary practice, though there is no fixed proportion for the thickness of such teeth in proportion to the pitch. The better the work the nearer the teeth can be to one-half the pitch. Much the same may be said of the other rule quoted. He also asks: Is the diametral pitch the number of teeth in every inch of circumference? *A.*—No; in every inch of pitch diameter.

(30) O. M., Peru, Ind., writes: Can you tell me anything about the feasibility of making artificial gas for use, say in small shops and a few dwellings? Can it be produced for fuel cheap enough to justify the expense of putting in a small plant? We have been thinking of it and desire to use it for driving two engines in shops about ½ mile apart, and to heat and light our own and perhaps one or two other dwellings. If you can give me any information on the subject, or put me in communication with those who can, it will be esteemed as a special favor. *A.*—If your shops are in an isolated locality it will undoubtedly pay you to put up a small gas plant for furnishing light in shops and dwellings; but we do not believe that it will pay to use the gas for fuel. If you are located in or near a large city, then the feasibility of putting up a plant will depend on the price of the gas furnished by the gas companies. There are many manufacturers of small gas plants who will be glad to furnish you with plans and cost of putting it up, which will enable you to decide in regard to the best course to pursue.

(31) B. W. T., Petrolia, Pa., writes: Kindly name three books on the following subjects which in your opinion are good ones, graphic statics, strength of material, and mechanics. The work on mechanics I would like to be one in which calculus is used freely. Also one that treats on the strength of material in a thorough analytical manner, and at the same time I do not want anything too voluminous, as my only time for study is in the evening. I have been much encouraged from time to time by your editorials on the subject of home study for mechanics, and will state, for the benefit of those who think it cannot be done, that I have become quite proficient in mathematics from the beginning up to calculus, without any help whatever, and have done it all in the evenings. I have also picked up drawing in the same way. I am not given to boasting, but mention this, first to give you credit for the many encouraging articles you have published, and to encourage others to help themselves. *A.*—Mechanics of Materials, by Prof. Mansfield Merriman; Graphic Statics, by the same author; and Elements of Analytical Mechanics, by Prof. De V. Wood.

(32) W. M., Paterson, N. J., writes: If the blades of a screw for a steamer have a certain pitch, the inner end of the blade having, of course, the greatest pitch, should not the pitch of the blades of a current wheel be reversed; that is, the outer end should have the greater pitch, as the water has to run off the outer end faster, on account of this part traveling through the larger circle? Is my reasoning correct? *A.*—We do not see a comparison between the two cases. All screw propellers for steamships have not an expanding pitch, as you seem to assume. A screw with an expanding pitch has a finer pitch at its leading or entering edge than at its following or posterior edge. The entering edge finds comparatively still water, while the following edge must act in water disturbed by the screw, hence the adoption of an expanding pitch. We have not been able to find the use of a screw recorded for a current wheel; the construction of nearly all these wheels resembles an ordinary paddle-wheel or modifications of it; and it seems to us that a screw is not suitable for this purpose, as considerable power will have to be expended in lost work.

(33) F. L., Baltimore, Md., asks: Does the lead in small marine engines or tugboat engines increase or decrease as the link is hooked up? *A.*—It generally increases. 2. Please tell me why the lead in a hoisting engine with a link motion is made to decrease as the link is being hooked up, and in locomotives made to increase? *A.*—In hoisting engines, a decrease of lead in hooking up the link is a matter of convenience; this enables the engineer to stop the engine without closing the throttle valve. In locomotives the link is used for changing the point of cut-off so as to work the steam expansively, and since in these engines the minimum amount of lead is at full stroke, a decrease of lead when the engine is cutting off earlier is not admissible, as this would tend to stop the engine. Of course, when a stationary link is used, the lead is constant for all cut-offs; but in shifting links the lead can be made to increase or decrease by connecting to it the eccentric rods in a suitable manner, as explained in our answer to Question 413, in our issue of Oct. 23, 1890. 3. Can copper be hardened? *A.*—In recent years it has been claimed that a method for hardening copper has been found, but we have no faith in it.

(34) P. J. B., ———, asks: 1. Please tell me what oil, or combination of oils, give the best results in hardening and tempering springs, where the old process of dipping in oil to harden and then blazing off for temper is followed. *A.*—We cannot say what oil, or mixture of oils, give the best results. Opinions of practical men differ very much on this point. Common fish-oil gives very good results, and many think the best results. Cotton-seed oil also seems to do very well in some shops. 2. Will the same oil be suitable for better hardening and tempering? *A.*—We hardly know what you mean by this. The quality of springs depends very much upon the steel used, and practically the same method is pursued for tempering all grades of springs, except that more care may be used with the better ones. 3. Will you also inform me as to whether there is any known means of hardening or case-hardening parts of small castings after they have been made in soft iron? *A.*—Heat the parts to be hardened in a lead bath to a cherry red. Put potash on them and dip in water. 4. Is there any way of hardening parts of small malleable castings after they have been annealed? *A.*—Heat the parts in a lead bath to a cherry red. Put cyanide of potassium on them and quench.

(35) O. C., Waco, Texas, sends us the following clipping from a paper: In the works of the Mannesmann Tube Company, in England, there is a heavy fly wheel ingeniously designed to be absolutely free from any danger of bursting. As this wheel is about 20 feet in diameter, weighs over 70 tons and runs at 240 turns per minute, it was feared that a cast-iron wheel would be unable to stand such a centrifugal force. The wheel consists of a cast-iron hub, to which are securely bolted two circular plates or disks of steel about twenty feet in diameter. Round the periphery of the wheel thus formed, about 70 tons of No. 5 wire was tightly wound, thus binding the whole securely together and making a wheel that is practically beyond the possibility of breakage by centrifugal power. The circumference of this great wheel travels at the rate of 2.85 miles per minute, about thee times as fast as the most speedy express trains. In regard to the above, he asks: Would like to know if this wheel was made as described, and running at a speed of 240 turns per minute? *A.*—We have no reason for doubting the statement, but whether the description is exactly correct, we are not in a position to say. It should be, however, understood that no fly wheel is absolutely safe at all speeds. Its safety is limited by the tensile strength of the metal.

(36) J. T. E., Duluth, Minn., writes: In designing a machine for traction purposes I have need of a boiler that will be more convenient than a vertical boiler, but as compact as possible, besides being so constructed as to leave no tubes or sheets liable to exposure when on a hill, as we expect to climb long and rather steep inclines. I have thought that a Scotch marine boiler might answer the purpose, but know very little as to the correct proportions of such boilers. Can you advise me in the matter? I will use a pair of 7x10-inch cylinders with plain slide valves. The greatest speed will be 200 revolutions per minute. *A.*—A Scotch marine boiler will be too bulky for your purpose. We should advise you to use a locomotive boiler with 6 square feet of grate surface, and 54 tubes 2 inches diameter; the length of the tubes should be such that their aggregate heating surface, plus the heating surface in the furnace, will be about 300 square feet. This size of boiler is suitable for soft coal; for hard coal you will need a larger grate surface. 2. What change would be required to allow us to use oil for fuel? *A.*—See our issue of April 7, 1888, page 5. 3. What publications can you recommend to give me the most information on the subjects indicated by the foregoing queries? *A.*—You cannot find all the information you seek in one or two books; to become a competent engineer you will need quite a library, and considerable practical experience.

(37) T. A., Chicago, writes: Please give me a rule for computing the change gears on milling machines for cutting spirals. *A.*—Select at random all the gears that are drivers, and all the driven ones except one. Consider the wheel on the screw as the first driver. Multiply all the drivers together, and this product by the lead of the screw (number of threads per inch), and by the pitch you wish to cut in inches. Divide this by the product of the selected driven gear and the number of teeth in the worm-wheel; the quotient will be the number of teeth in the remaining driven gear. Or, if you prefer, you may select all the driven gears and all the drivers except one, in which case multiply the driven gears and the teeth of the worm-wheel together, and divide this product by the product of the number of teeth in the selected driver, by the number of threads per inch in the screw, and by the pitch of the spiral to be cut, in inches. These rules may be stated thus:

$$d = \frac{D\,D_1\,S\,P}{d_1\,W}, \text{ or,}$$

$$D = \frac{d\,d_1\,W}{D_1\,S\,P}$$

in which

S = threads per inch in screw,
W = number of teeth in worm-wheel,
P = pitch of spiral to be cut in inches,
D = number of teeth of first driver,
D_1 = number of teeth of second driver,
d = number of teeth of first driver,
d_1 = number of teeth of second driver.

2. Please also give a rule for obtaining the number of turns and holes to move the index pin to obtain a given division. *A.*—Divide the number of teeth in the worm-wheel by the number of divisions you wish to cut; the quotient will be the number of turns of the index pin necessary to be made. If this is a whole number any plate will do, but if it is a fractional or a mixed number, first reduce it to its lowest terms, then a circle must be selected which is equal to or a multiple of the denominator of that fraction. Then divide the number of holes in the circle by the denominator of the fraction, and multiply the quotient by the numerator. The product will be the number of holes required. For instance, suppose the worm-wheel contains 40 teeth, and it is desired to cut 18 divisions. Then dividing 40 by 18 we get $2\frac{4}{18}$, which shows that the pin must make two turns and four-eighteenths of a turn for each division; four-eighteenths reduced to its lowest terms is two-ninths; and we may take a circle of 18 holes or 27 or 36, because all these are multiples of 9. Taking the 18 circle we divide it by 9 and get 2; multiplying this by 2 we get 4, and we must, therefore, turn the pin two turns and four holes. If we had chosen the 36 circle, then we would have had two turns and eight holes, because $36 \div 9 = 4$, and $4 \times 2 = 8$.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

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"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th St., New York.

MANUFACTURES.

A 100 ton iron furnace is reported as to be built at Front Royal, Va.

Miller Bros. contemplate the erection of a foundry at Columbia, S. C.

A $100,000 cotton factory is reported as to be erected at Cheraw, S. C.

G. B. Gray, of Oakland, Cal., will establish a nail factory at Seattle, Wash.

A hardware factory, to cost $26,700, is to be established at Middleville, Mich.

It is probable that an iron foundry will be established at Weatherford, Tex.

The Roanoke (Va.) Machine Works will probably build a $25,000 blacksmith shop.

The Ettrick cotton factory, Petersburg, Va., is reported as to be put in operation.

Houston, Stanwood and Gamble are reported as to erect engine works at Covington, Ky.

Northern parties are reported as to remove a $500,000 nut and bolt factory to Fort Payne, Ala.

The new building of the Muskegon (Mich.) Foundry and Machine Company is nearing completion.

It is stated that the Norfolk & Western Railroad Company will establish car shops at Radford, Va.

The Georgia, Carolina & Northern Railroad Company proposes to build machine shops at Abbeville, S. C.

Paulus & Williamson Architectural Iron Co. has been incorporated at St. Louis; capital stock, $10,000.

The Dayton Steel Chain Company of Dayton, O., has been incorporated, with a capital stock of $15,000.

It is finally decided that Mitchell & Co., the Scotch manufacturers of gingham, will locate in Fitchburg, Mass.

The Argonaut Cotton-mill Company, Covington, Ky., are to place $100,000 worth of new machinery in their mill.

A $100,000 cotton factory is reported as to be erected at Cheraw, S. C. H. L. Souchlin can give information.

The Texas Car and Lumber Company, Tyler, Texas, will, it is reported, double the capacity of its car works.

W. H. Phillips, of Taunton, Mass., will, it is stated, probably remove his foundry and machine shops to Middlesborough, Ky.

Pittsburgh (Pa.) capitalists are investigating with a view of establishing an iron foundry and novelty works in East Texas.

It is reported that the Tredegar Cotton Manufacturing Company, at Jacksonville, Ala., is about to erect a cotton-mill.

The Maryland Tack and Wire Nail Company, capitalized at $50,000, are erecting a factory 195x65 feet at Front Royal, Va.

The Naoma Falls Manufacturing Company, of Randleman, N. C., contemplates putting additional machinery in its cotton-mill.

The A. T. George Motor Company, of Kansas City, Mo., has been incorporated, to manufacture spring motors for street cars.

Work on the new factory of the South Wareham (Mass.) Nail Works is being pushed rapidly forward. New machines are to be put in.

The Dickson Car Wheel Company, of Houston, Texas, is increasing the capacity of its works, putting in new machinery, etc.

Work has been begun on the pulp-mill at Huntsville, Ala., which is to be erected at a cost of $80,000 by the American Fiber Company.

It is reported that Haselton, Pa., is to have a nail factory of $120,000 capital stock. It is to be established on the co-operative principle.

The Schofield Metal Cross Tie Company has been incorporated at Chattanooga, with a capital stock of $100,000. L. Schofield is president.

The organization of a $100,000 stock company, to erect a cotton-mill, is projected at Anderson, S. C. J. A. Brock can give information.

It is stated at Fort Payne, Ala., that negotiations are pending for the removal of a nut and bolt factory from the North to Fort Payne.

The Sherman Iron and Brass Works will, it is stated, commence the manufacture of cars at its brass and iron works at Sherman, Tex.

The Cincinnati Southern Railway Company (office, Cincinnati, O.,) will, it is reported erect a machine shop and roundhouse in Lexington, Ky.

The iron foundry and machine shop of the American Bridge and Iron Company, at Roanoke, Va., recently damaged by fire, will be rebuilt.

A foundry, wheel and handle works will probably be established at Jasper, Tenn. The Jasper City Land and Mining Company is interested.

At a recent meeting of the directors of the Newnan Cotton-mills of Newnan, Ga., it was decided to purchase $15,000 worth of new machinery.

M. T. Holland, of St. Louis, Mo., will it is reported, establish in Middlesborough, Ky., works for the manufacture of steam and water registers.

The Brooks Axe and Edge Tool Works, at Brooksville, Vt., will probably be reopened in the spring by a new company having a capital of $50,000.

Machine works for the manufacture of saw-mill machinery will probably be moved from Michigan to Buchanan, Va. I. Z. Schultz can give information.

It is stated that the Rogers-Spencer Company, of Springfield, Ohio, are investigating Roanoke, Va., with a view of moving their plant to the latter place.

The Louisville (Ky.) Cotton-mills Company has increased its capital stock $50,000, and will put additional machinery in its cotton-mill, as reported last week.

James Ogilvie, Glen Varie, Scotland, will, it is reported, erect a woolen-mill at Pittsburgh, Pa., in which New York and Glasgow capitalists will be interested.

Coffrode & Evans, of Philadelphia, Pa., are reported as having received contract for erecting the blacksmith shop of the Roanoke Machine Works at Roanoke, Va.

The Fairmont Machine Works Company has been incorporated, with a capital stock of $100,000, to build an iron foundry and machine shop at Fairmont, W. Va.

A $50,000 stock company has, it is stated, purchased 20 acres of land near Greenwood, S. C., on which it will erect machine shops, planing-mills, repair shops, etc.

The Harless Car Door Company has been organized at Anniston, Ala., and will probably erect a factory for the manufacture of the J. D. Harless patent car door.

There is talk of a new industry at East Hampton, Mass. The ivory button works at Bridgeport, Conn., will probably move there. A building will be erected for them.

It is stated at Buchanan, Va., that a Michigan machine works plant that makes a specialty of manufacturing saw-mill machinery, is likely to be moved to Buchanan.

The Louisville Cotton-mills Company, of Louisville, Ky., has increased its capital stock $50,000, and will put additional machinery in its cotton-mill as reported last week.

M. B. Reber, J. C. Neal and others have incorporated, at Charleston, W. Va., the New York & Ohio Co., for the purpose of manufacturing machinery, electrical supplies, etc.

It is stated that a stove foundry and iron works establishment will be moved to Clifton Forge, Va. The Clifton Forge Mining and Development Company can give information.

The new car wheel works at Jefferson, Texas, have been completed, and now await the final construction of the Lone Star Iron Company's furnace, which will go into blast soon.

The Crucible Iron and Steel Works, East St. Louis, Ill., will nearly double their capacity by the erection of a new foundry 100x64 feet. The improvements will cost $100,000.

Ishpeming, Mich., has been selected as the site for a foundry to be erected by Carlos Sheldon and Seymour Holly, of Houghton. There will also be a machine shop for supplying mining machinery.

B. J. King, S. G. Van Dyke, J. R. Gray and others have incorporated the Southern Metal Company, at Atlanta, Ga., to manufacture all kinds of metals, machinery, tools, etc. The capital stock is $100,000.

The Buda Iron Works, of Buda, Ill., capital $24,000, for the manufacture of railway supplies and architectural iron work, has been incorporated by M. J. Knipple, A. J. Fisher, L. J. Akin and S. Toomey.

Rockford, Ill., is figuring for the removal to that city of the Standard Foundry and Manufacturing Company, of Cleveland, Ohio, which gives employment to 250 men, and daily melts 20,000 pounds of iron.

Henry Essex, W. H. Smith, E. M. Eaton and others have incorporated at Chattanooga, Tenn., the Essex & Smith Manufacturing Company, to deal in and manufacture castings, implements and machinery.

At Buchanan, Va., J. D. Weeks, E. Dillon, M. H. Payne and others have organized the Buchanan Steel Works, for the purpose of manufacturing steel by the Adams direct process. The capital stock is $100,000.

C. D. Crandal and C. J. Stebbins will shortly begin the manufacture of brush blocks, handles and other light wood-work, at 616 N. Commercial street, St. Louis, Mo., under the firm name of Crandal & Stebbins.

There is water-works agitation in Fort Valley, Ga.; Richmond, Mo.; Highland, Ala.; Foxboro, Mass.; New Britain, Conn.; Liberty, Neb.; Scranton, Miss.; Arcadia, Neb.; Oakland, Neb.; Wilson, N. C.; Quincy, Mass.

The Ryan-McDonald Mfg. Company, of Waterloo, N. Y., are to remove their machine works to Curtis Bay, Md., where a company with $100,000 capital stock will be incorporated, and where a building 350x70 feet will be erected.

Parties from Kansas City, Mo., Springfie,d, Ohio, and Sherman, Texas, have been investigating with a view of establishing stove and machine works at a cost of $150,000 in Corsicana, Tex. Evans & Young can give information.

The Western Rolling Stock Company, of Chicago, has been incorporated with a capital stock of $100,000, by George E. Farley, Grant S. Wheeler and William E. W. Johnson. It will manufacture cars, engines and other rolling stock.

The Indianapolis Car Works, at Indianapolis-Ind., have been purchased by a syndicate of creditors represented by Edward Pollock, of Cincinnati, Ohio, for $52,500. The purchasers propose to resume the operation of the plant.

The Pittsburgh (Pa.) Portable Forge Company, recently organized in Pittsburgh, have commenced the erection of their plant on Smallman street, in that city. In addition to forges they will manufacture railings, gratings and steel barrows.

The Canonsburg Iron and Steel Company, of Canonsburg, Pa., has decided to greatly enlarge its capacity. The firm manufactures sheet-iron and steel for stamping purposes and galvanizing. The present capacity is about 4,000 tons per year.

The Knoxville Car Wheel Company is reported as having leased the foundry and machine shops of the Knoxville Foundry and Machine Company, Knoxville, Tenn., put in new machinery and established a brass foundry in connection with same.

The George L. Squier Manufacturing Company, of Buffalo, N. Y., has awarded contract to J. H. Stewart for the erection of machine works in Glasgow, Va., and will remove its plant and add the manufacture of agricultural implements, hardware, etc.

A corporation, to be known as the Haywood Foundry Company, has been organized at Portland, Me. The company has a capital stock of $150,000; its officers are: President, Earl A. Thissel, of Florence, Mass.; treasurer, H. Warner, of Florence, Mass.

New repair shops are being erected at Nicetown, Pa., by the Philadelphia & Reading, to take the place of the old shops at Third and Berks streets, in Philadelphia. The new building will be 307x176 feet, with an extension 25x36 feet. Construction has begun.

The Gennett Air-brake Company has been incorporated, with headquarters at Chicago, to manufacture air-brakes. The authorized capital stock is $800,000, and the incorporators are: David Wallach, Philip Opper, Isaac Neuberger and Moses L. Rothchild.

Articles of incorporation for a woolen-mill at Stockton, Cal., to employ about 100 white persons, have been filed. The paid-up capital is $50,000. The new company will remodel and enlarge the Stockton mills, and put in new machinery throughout.

A corporation known as the Victor Electric Company has been organized, with a capital stock of $100,000, at Kittery, Me., for the purpose of manufacturing electrical apparatus. The officers are: President, F. H. Pray of Boston, Mass.; treasurer, John Hobbs of Boston, Mass.

The Great National Smelting Company has been organized, with a capital stock of $1,000,000. Articles of incorporation were filed at Pueblo, Colo., on the 24th ult., by Benjamin Semon and William Guggenheim. The object is to conduct a general smelting business at Monterey, Mexico.

The National Pipe Bending Company, of New Haven, Conn., have recently opened branch offices at 15 Cortlandt street, New York, in charge of Mr. J. J. Nef, and 8 Oliver street, Boston, in charge of Mr. T. P. Lennox. The company is just completing new works, which will greatly increase their capacity.

C. W. Smith is president, Henry Essex, vice-president, and W. H. Smith, secretary of the Essex & Smith Manufacturing Company, Chattanooga, Tenn., incorporated to manufacture castings, implements and machinery. Site has been secured and buildings will be erected at once. The capital stock is $30,000.

The South Tredegar Rolling-mill at Chattanooga, Tenn., has been closed pending negotiations for the sale of the plant. It is stated that a $600,000 company, to be known as the South Tredegar Iron Company, of Cardiff, Tenn., is being organized by eastern parties for the purpose of purchasing the mills and moving them to Cardiff.

South Superior has secured three new manufacturing plants. They are: Racine Malleable Iron Works, of Racine, Wis.; Pittston Stove Works, of Pittston, Pa.; and the Elms Buggy and Carriage Works, of Jackson, Mich. The construction of buildings for these concerns will commence as soon as the weather is mild enough in the spring.

The new muffle-room for The Scovill Manufacturing Company at Waterbury, Conn., is now completed. The side walls are of brick, and the roof is of iron designed and built by The Berlin Iron Bridge Company of East Berlin, Conn. The same company have also just completed a new boiler house for The Orono Pulp and Paper Company at Basin Mills, Me.

Several new establishments have been located at Curtis Bay, adjoining the South Baltimore Car Works. The South Baltimore Foundry Company has completed its plant and is now filling orders. Foundations have been laid for the Ryan-McDonald Machine Works. These works will be under the management of Mr. Howard Carlton, who is also general manager of the car works.

Recently it was announced that the Pennsylvania Steel Works had opened an additional industry at their plant for the furnishing of materials for the construction of bridges of iron or steel. This new department is now ready, and is already at work in the specifications for the construction of railroad bridges. When fully under way a large number of skilled mechanics will be employed to execute the work. Mr. C. E. Bilting is the superintendent of the department.

The Georgia Rolling Stock Company has been organized at Macon, Ga., to manufacture and repair railway cars. The capital stock is $1,000,000. In order that the mechanics and workingmen of Macon may have a direct interest in this enterprise, it has been decided to issue to them, and to them only, first preferred guaranteed 7 per cent. stock to the amount of $100,000. Subscriptions for this are payable, 10 per cent. when organized, 10 per cent. 60 days later, and 10 per cent. a month thereafter until the entire amount has been paid.

The removal of the Grant Locomotive Works from Paterson, and their establishment on an enlarged scale at Chicago, are notable events in their way. A number of engines have been built in railroad shops in the West, but the new Grant Works will be the first large shop building locomotives for sale which has been placed west of Pittsburgh for a number of years. The new works will be provided with all the improvements in buildings and plant, which long experience in the business may suggest to their owners and builders.

It is said that stockholders in the Pennsylvania Railroad Company will build extensive car works at Milwaukee, Wis. A large tract of land has been secured and a company organized with a capital stock of $800,000, of which between $500,000 and $600,000 has been subscribed. They will be the finest and most extensive car works in the country. Work will be commenced as soon as the weather will permit in the spring. It will doubtless be the means of bringing other manufacturing institutions to Milwaukee, and it may give that city greater railroad facilities.

The Toledo Machine Tool Works, Toledo, O., formerly owned and operated by G. H. Danielson, has been changed into an incorporated company, with $30,000 capital stock, under the style of the Toledo Machine and Tool Company. Mr. Danielson will continue with the new company as manager of the business, which, as heretofore, will be the manufacture of presses, dies, special machinery and all kinds of sheet-metal tools. The names of the incorporators of the company are: G. H. Danielson, E. A. Phillips, E. P. Breckenridge, E. A. Edwards and J. D. Riggs.

The Great Western Locomotive Works have been incorporated, to build works in Chicago for the manufacture of locomotives and machinery. The capital stock is $1,000,000, and the following are the incorporators: Alfred Skinner, Hugh R. Walker and Thomas A. Wigham. No site has been selected, but the works are to be located in or near Chicago, and will cover nine acres of ground. The old Chicago Railway Supply Company, of which H. R. Walker is president, will be absorbed by the new organization. It is said that work will be commenced on the buildings in the spring.—*Railway Age.*

It is stated that the Bristol, Elizabethton & North Carolina Railroad Company, the Doe Mountain Mining and Manufacturing Company, the South Bristol Land and Improvement Company, the Crab Orchard Coal Company, the Pioneer Steel Company, the Pioneer Land Company, and possibly the Bristol Iron and Steel Company, and the Ironton (New Jersey) Steel Company will consolidate, and thus will control 20,000 acres of iron lands, 18,000 acres of coal lands, 5,000 acres of town property in Bristol, Tenn., and a town site at Mountain City. The consolidated company will also, it is reported, build an immense steel plant in South Bristol. The capital stock is $10,000,000.

The announcement is made that a large plant will be established in Glasgow, Va., employing 500 men, for the manufacture of passenger, baggage, postal, refrigerator and freight cars, to be constructed entirely of steel, the only wood entering into their make-up being a few strips in the steel frame to assist in fastening the outer covering. Not only is the framework of steel, but the outer sheathing, inside panels, in fact, the entire car is of the same metal. It is claimed for these cars that they will be more durable, cost less for repairs and maintenance, and be practically indestructible by fire. They will carry a heavier load than the wooden cars, thus increasing the amount of freight carried and reducing the dead weight.

The H. B. Smith Machine Company having concluded with the expiration of its ten years lease of 925 Market street, occurring January 1st, 1891, to withdraw from the general machinery business in Philadelphia, J. J. White, manager of the H. B. Smith Machine Company's Philadelphia store during the past ten years, has, in connection with others, organized the Pennsylvania Machine Company, Limited, and with his former associates and salesmen will continue the general machinery commission business at Nos. 29 and 31 North Seventh street, Philadelphia. The Pennsylvania Machine Company, Limited, will conduct the Philadelphia business of H. B. Smith Machine Company, woodworking machinery; P. Blaisdell & Co., machine tools; Fitchburg Machine Works, machine tools; Chandler & Taylor Co., self-contained engines; Snell & Meharg, vertical engines; E. Kendall & Son, hoisting engines; Windsor Machine Company, screw cutting machinery.

The Buffalo Railroad Supply Company, which was recently incorporated, with a capital stock of $100,000, has purchased five acres of land at the crossing of the Delaware, Lackawanna & Western, the Lehigh Valley, and the Western New York & Pennsylvania Railroads in Buffalo, and has begun the erection of large buildings, the principal one being 500 feet in length, and another 250 feet. These buildings will be fitted up with new machinery, and work will be begun as soon as possible. The company will manufacture switches and fixtures, frogs and crossings, car axles, links and pins, and many other articles used by railroads, besides making brass and iron castings of all descriptions and general machinery. It has succeeded to the business of the Buffalo Frog and Crossing Company, and has also acquired control of several patents for feed-water heaters, and purifiers for boilers. The officers of the company are: Sydney E. Adams, president; M. M. Drake, vice-president; W. A. Clemens, treasurer; Virgil H. McConnell, secretary and manager.

It will not require many more such demonstrations of the lawless violence of the ignorant immigrant populations that have been pouring into this country, as that which was made by the Hungarian rioters at Braddock, Pa., to convince reflecting people that something must be done to put a curb on that element. This wild mob of foreign laborers, armed with clubs, knives and revolvers, made an attack on the English-speaking workmen who were employed in the works of the steel company, and although they did not succeed in destroying the works, they did murder one of the workmen and seriously wounded many others. The only reason assigned for this murderous mob attack was that those who made it were determined that skilled workmen should not remain at work for the company unless the demands made by the unskilled laborers were complied with. These ignorant foreigners, few of whom can speak our language, have somehow imbibed the notion that in this country they can do whatever they may please to do with impunity. They have no kind of correct apprehension of what liberty or freedom properly means; they interpret them to mean unrestrained license, absolute lawlessness. It is time, not only that these classes of immigrants should be made to understand that law in this country is just as powerful to preserve order and enforce obedience to its mandates as in a monarchial country, but that we should have effective national legislation for the purpose of restricting and preventing the immigration into this country of these ignorant, lawless and dangerous people.—*Jersey City Evening Journal.*

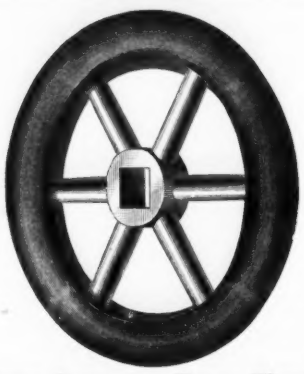
The German Agricultural Society is in want of a dynamometer for arriving at the resistance of vehicles, and offers a prize of 400 marks to be awarded in March, 1891, by a commission appointed for the purpose. The dynamometer must register from 500 to 5,500 pounds, but different springs may be used. Those desirous of competing should address: German Agricultural Society, Deutsche Landwirthschafts-Gesellschaft, Zimmerstrasse 8, Berlin, S. W.

Plate-shearing Machine.

The accompanying illustration, reproduced, with the description, from *Industries*, represents a strong plate-shearing machine, made by Messrs. Francis Berry & Sons, Calderdale Iron Works, Sowerby Bridge. This machine is capable of shearing copper plates up to 1⅛ inches thick, and iron plates in proportion to the relative shearing resistances. It will admit a plate 2 feet 9 inches wide between the standards. The gaps in the standards are 18 inches deep, and the shear blades are 4 feet long. The machine is powerfully geared, and is driven by a special steam engine affixed to the framing. Disengaging motion is fitted with a handle shown on the left. Messrs. Francis Berry & Sons have supplied a number of these machines to the principal rolling-mills and forges both at home and abroad. A scrap shear can be fitted at one end of the machine, if necessary, for cutting up the waste made from the large shears. This machine is strongly made and well proportioned, and has been designed with a special regard to the rough usage of the forge or rolling-mill. We understand that machines have been supplied for shearing plates up to 1½ inches thick, and to admit a plate 7 feet 6 inches wide between the standards.

A Year's Shipbuilding on the Mersey.

The returns from the principal firms of shipbuilders on the Mersey show that during the year now closing business has been fairly active, though the total tonnage turned out in 1890 does not equal that of the previous year. Messrs. Laird Bros. have built the following steamers, all of steel: The "Ottoman," 4,843 tons gross register, and 3,000 indicated horse-power; the yacht "Norseman," 231 tons, and 350 horse-power; the Chilian gunboats, "Almirante Lynch" and "Almirante Condell," each of 613 tons, and 4,500 horse-power; the gunboats "Espora" and "Rosales," each of 433 tons, and 3,250 horse-power; and the man-of-war "9 de Julio," 2,000 tons, and 3,000 horse-power. The last three are for the Argentine Confederation. In addition to the above, Messrs. Laird Brothers have also constructed the engines for H. M. S. "Speedwell" and "Skipjack," each of 4,000 horse-power, and those for the paddle steamer "Violet," also of 4,000 horse-power. Messrs. Thomas Royden & Sons have built the following vessels, all for Liverpool owners: The steel steamers "Indrapura," 3,859 tons gross, and 1,800 indicated horse-power; "Saladin," 1,998 tons, and 1,000 horse-power; and "Obidense," 2,379 tons, and 2,400 horse-power; and also the steel sailing ship "Crompton," 2,809 tons. Messrs. W. H. Potter & Sons' list comprise the iron steamer "Gorgon," 986 tons, and 660 horse-power; and the sailing ships "Altair," 2,452 tons, and "Dunfermline," 2,902 tons. Messrs. R. & J. Evans & Co. have built the iron ship "Atacania," 1,142 tons, and have also been busy in repair work all through the year. Messrs. Harland & Co. have turned out the wooden sailing barge "Aileen," 70 tons; and, in addition to repair work, they have now on hand a wooden steam barge, to carry about 300 tons. Messrs. Clover, Clayton and Co., who lay themselves out specially for repairs, have been moderately busy during the year. Their principal job has been the restoration of the steamship "Ligurian." The fore end of this vessel, after having been abandoned by the underwriters, was purchased by Messrs. Clover, Clayton & Co., ballasted, bulkheaded, and successfully floated into their graving dock, the after part having been floated by the Salvage Association. The two ends were put together, and the vessel restored to her original class in Lloyd's. The same firm have also had in hand several Norwegian and German wooden vessels to repair and re-class. Mr. William Newall, of Garston Dock, has been fairly busy in repairs, and the same may be said generally of all the leading firms. There are a good number of orders on hand for the coming year, the prospects of which are encouraging. The total tonnage turned out during the year is 27,763, as compared with 35,773 tons in 1889, 22,538 in 1888, 10,664 in 1887, and 20,966 in 1886.—*The Engineer and Iron Trades Advertiser.*



RUBBER COVER FOR VALVE WHEELS.

Rubber Covers for Valve Wheels.

Much inconvenience and annoyance is often experienced in opening or closing steam valves with metallic hand-wheels, which become heated. To overcome this trouble, Jenkins Bros., 71 John street, New York, have placed on the market rubber covers shown in the illustration. They are extremely simple and durable; and, since rubber is a non-conductor of heat, these covers form an excellent protection from burning of the hands. They are easily applied; all that is necessary is to stretch the cover over the wheel, and in a few days, if the wheel is hot, it will adhere strongly to the metal. The cover can also be easily removed from an old wheel and applied to a new one. The rubber is made of a special composition, and will not burn on any hot wheel. The covers are well adapted for any kinds of valve wheels, water combinations and gauge cocks, and are especially valuable in dye houses and laundries, where the wheels are often handled with wet hands, and, as these cannot slip on rubber, a seating of the valves is always insured.

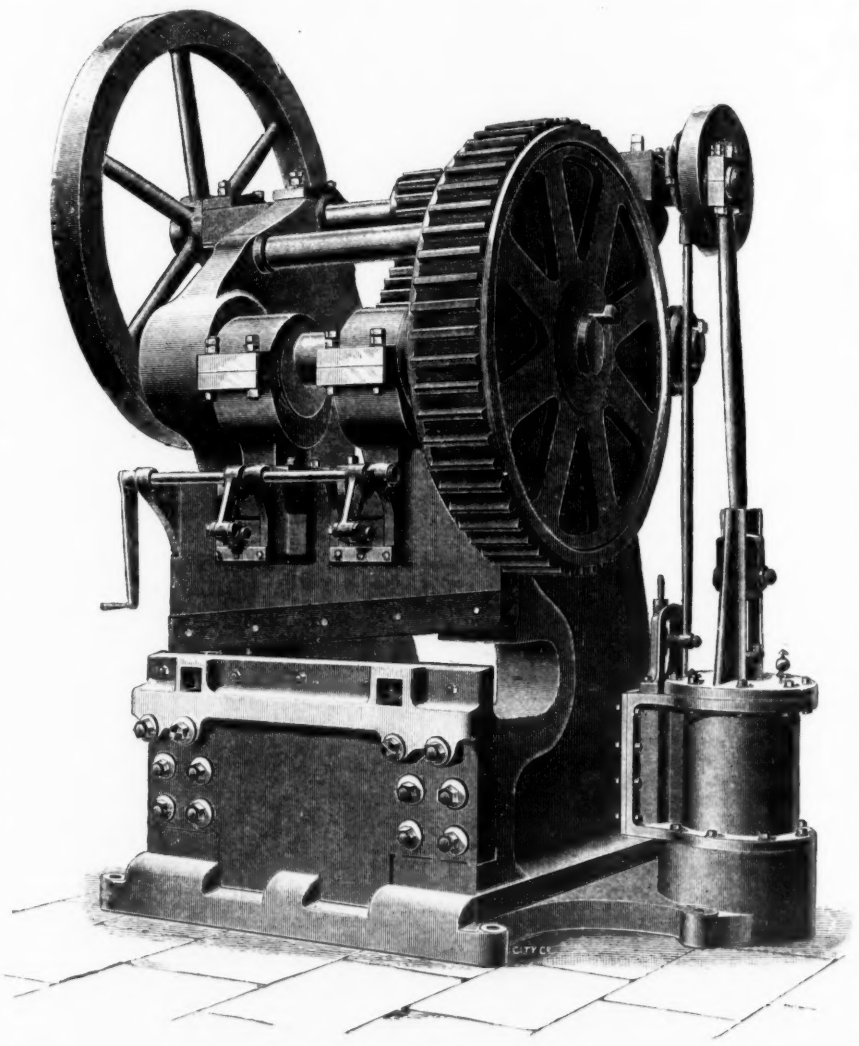


PLATE-SHEARING MACHINE

According to the commissioner of labor, railroad employes in this country earn something less than $500 a year, on an average.

Doings at Backaway.

Mr. Editor:

Some time since I wrote you that, incited thereunto by Smeaton, I was going to put an estimate for a compound engine to take the place of our present engine before the directors of the G. & I. As the time for the directors' meeting drew near I saw the necessity of getting to work. First, for my guidance, I drew up a statement in a few lines, setting forth the cost of a new engine and the probable saving in coal. Then I proceeded to make a statement; I showed where the heat went, and why it went there, according to the best information I had on the subject. Went into advantages of expansion and the loss from condensation as far as I could, giving the best reason I could for everything, quoting freely from the highest authorities to sustain me and fortify my tables. When I had that report concluded, it covered several pages of foolscap, and—well, I felt proud of it. By a little study as I went along I could understand it fairly well.

Two days before the meeting of the directors, Smeaton came around and asked if the report we were talking of was ready. I opened the desk and handed it to him. He looked it over carefully, and finally said:

"Oldone, what do you mean by B. T. U?" I explained that these letters stood for British thermal units, an expression in general use by engineers in discussing the production and utilization of heat. Several other abbreviations were inquired into, then Smeaton said:

"You might just as well fire off a composition in Greek at the directors as to present that report. They would know just as much about one as the other, with the chances in favor of the Greek composition on a revival of schoolboy days. If you," continued Smeaton, "were to write to them about profit and loss, and discounts, or the prospects of trade with South America, they would appreciate what you were driving at. But as to the body of that report, they would know less than I do about it, and that is just nothing. The men who act as directors of this company are business men. They know a good deal about business and nothing about steam engineering. They have no reason to know anything about steam engineering."

I felt bad. I had spent a good deal of time in getting that report ready.

I made another effort to satisfy Smeaton, and in doing so took my little dozen-line memorandum out of the desk to convince him that my figures were right. He took it out of my hand, and in less time than I can write it there was an expansive smile on his countenance.

"Why, Oldone, you've got right here just what the directors want. This gives the cost of the change and the estimated saving, and that is exactly what they must know, and all they want to know; you just copy this prefacing it with not more than a half dozen lines, and sign your name to it as chief engineer."

When I had that report complete—and Smeaton stayed right with me till I wrote it out—it read as follows:

BACKAWAY, Nov. 20, 1890.

To the Directors of the G. & I. Mills.

GENTLEMEN:—I have examined, with considerable care, the engine now in use driving the machinery in these mills. I find this engine must develop 365 horse-power, and that, to furnish the steam necessary to operate it, we must burn 12,000 pounds of coal per day, costing $21. I have also made careful estimates of the cost of a compound engine to take the place of the present one, as well as the probable coal consumption with the new engine. I find the cost will be $9,000, and that the coal burned will be 7500 lbs., costing $13.

This represents a saving of $2,400, which is 25 per cent. on the cost of the new engine. I also estimate that the new engine will govern closer than the old one, and that this feature will enable us to increase the speed of machinery by five per cent., thereby increasing the output to about that extent.

The change will also save the cost of another boiler, and I recommend that it be made.

Very Respectfully,
JOEL OLDONE, Chief Engineer.

I don't know what Smeaton said in favor of the plan, but the order for the new engine is to be given at once.

The repair shop connected with the G. & I. mills isn't a large one, as repair shops go; ten men is the usual complement. When I was appointed to my present position I anticipated a good deal of pleasure in being around that machine shop. I should have plenty of time—so I thought—and being there would carry me back to the old times, when I traveled as a journeyman machinist. But I soon found out if I looked after the steam plant and the machinery in the mill there was no time to look after machine shop details. When a breakdown occurs I find it advisable to be, for the most part of the time, where the breakdown is. The machine shop is hardly large enough for a foreman who keeps his coat on. He would get tired walking around in his rather limited quarters and doing what little bossing was required. But even ten men must have some looking after.

Under the fostering care of Jones they waited for him to come around and tell them whether to make provision for holding a pulley with a key or with one or two set-screws—waited for him to come around, if it took a half-day. They were not paid for taking any responsibility, and experience had taught them better than to take liberties with Jones.

I couldn't be in the shop much, and I wanted to provide against delays incident to my absence. Smeaton helped me out, "advised" me, as usual.

Smeaton said to me, "If I were you, I would select the best man in the shop, raise his pay enough to make it an object, and let him look after things, giving him reasonable authority. I would do this with the understanding that he should work when not telling others what to do, and, if necessary, how to do it."

I slept over the matter, and the next day

offered the position to Jennings, who accepted it.

Jennings is a middle-aged man, a first-class machinist, and has been in the employ of the G. & I. for twelve years—long enough to understand the needs of the mill. All orders for the machine shop went through Jennings after that. He took hold of the shop matters and everything went smoothly. In a few days he came to me saying we required more tools. As the machinery in the mill got older, more repairs were required to keep it in first-class running order. Some of the machines required an almost entire rebuilding.

I asked if another lathe would help him out. Yes, it would help him, but he had a different idea in the matter. Said he, "There is a good deal of machine work that isn't done as it was when you and I were boys. You see that lathe over in the corner?"

I saw it. "Well," he continued, "there is one piece that is used on a large number of machines in the mill, and that lathe is employed constantly in making these pieces—making them in lots of twenty-five or more. Last summer I took a few days to see what other folks were doing. I stopped at Bridgeway and I saw a machine there—made for the market—with which four of these pieces could be made as often as one is made in the lathe. The machine will cost more than a lathe, but it will do four times the work, and I have no doubt we can find a way of doing a great many other standard pieces on it. If we do, it will probably set two or three lathes at liberty for other work which is required, and set at liberty as many men to run them."

I shall see that machine, and if Jennings is right, of which I have little doubt, Smeaton will see that we have it.

JOEL OLDONE.

In Manchester, England, gas is 60 cents per 1,000 feet, and the city makes $350,000 yearly profit. In Leeds, gas is 44 cents; in London it is 64 cents, and pays big dividends to private companies. It costs more probably to carry coal to London from the Midlands than it would from America. London is subject to fogs towards the end of every year. The smoke of soft coal makes the fog black and noxious, just as it may be seen in New York City when the steam fire engines, burning English coal, are turned out on a foggy day.

Anthracite coal is dear in London. Why should not American anthracite be tried there? It would at least prevent the present blackening of the city, though it may be doubted whether the large proportion of sulphur it contains would not be a drawback.

W. H. B.

It appears as though sailing vessels were making a last effort, as it were, against steam propulsion for a share of the carrying trade of the world. Within the past two years enormous sailing vessels, some of them of steel, have been built, but everything points to small chance for their success in competition with steam. Mechanical skill has brought the marine engine to such a state of efficiency that the accident of wind is put to too great a disadvantage to compete. Then modern ways of doing business is against the uncertainties of the vessel that must depend upon the fortune of wind. Cargoes must come to hand within very small limits as to time, to meet modern requirements, and steam alone can insure this.

A good deal is said of the advantages that would result to poor people by reducing letter postage to one cent. It appears to us that the advantage is more apparent than it would be real. The great bulk of letters that go through the mails are from business houses. While plain John Smith would perhaps save fifty cents a year, his employers might save two hundred dollars. It appears to us that, if the government gets too much revenue from its postal service, it would be better to improve that service, charging two cents for carrying a letter, at least for some years to come.

The walking beam of the Pennsylvania ferryboat Baltimore broke recently, and occasioned her suspension from service. The accident is presumed to have been the result of frost. The boat's hull suffered little damage. No one was injured.—*Daily Papers.*

We presume that the beam broke because of inherent weakness, either from not having been properly proportioned, or from some flaw. With the weather mild enough to shed an overcoat, it is rather rough to pile all these troubles on Jack Frost.

Another evidence that the days of steam power are numbered is to be found in a Broadway store, where a sign in the window reads: "Electricity is taking the place of steam, and we are selling these $1.00 steam engines for 75 cents."

The price of boiler material in this country fifty years ago was: Copper plate, 34 cents; iron, 16 cents; cast-iron, 6 cents per pound. Boilers were costly luxuries in those days.

Machinists' Supplies and Iron.

NEW YORK, January 10, 1891.

Iron—American Pig—The feeling at present is quiet, and no one seems inclined to do more business than circumstances require, consumers only covering their immediate wants. The prices of the Thomas Iron Company for the year have not yet been announced.

We quote No. 1 Foundry, standard Northern brands, $16.50 to $17.50; No. 2, $16 to $16.50; Gray Forge, $15 to $15.50; Southern brands No. 1 Foundry, $16.25 to $16.75; No. 2, $15.75 to $16; No. 3, $14.25 to $14.50.

Scotch Pig—The market continues dull.

We quote Coltness, $24.50; Dalmellington, $22 to $22.50, and Eglinton, $20.50.

Copper—The price of Lake seems to have settled down at 15c., and it is understood that it can be contracted for with the Lake companies at that figure for future deliveries.

Lead—Higher prices seem still to be expected by some of those who have stock to sell, and they show a disposition to hold on. Consumers on the other hand show very little disposition to buy, except for immediate wants. Values are at about 4.30c. to 4.45c.

Spelter—The market is dull, though there has not seemed to be much surplus on hand.

We quote ordinary brands of Western at 5.90c. to 6c.; choice, 6¼c. to 6¼c.; refined, 7¾c. to 8c.; Silesian, 7⅞c. to 7½c.

Tin—Prices are somewhat firmer, though very little new business has transpired. Values are at about 20c.

Antimony—There has been a moderate demand for Regulus. We quote Hallett's, 16½c. to 16¾c.; Cookson's, 18¾c. to 18¾c.

Lard Oil—Prices have advanced slightly, and are now 49½c. to 50c. for Prime.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Exp'd mech'l engineer and draftsman, every qualifica'n, desires responsible position. Box 321, Chicago.

Wanted—Position by mech. draftsman, good designer, 9 years exp. in shop. Jos. Lisk, Palmyra, N.Y.

Experienced mechanical draftsman wants position. Address Box 31, AMERICAN MACHINIST.

Wanted—A mechanical draftsman who has had some experience in engine designing. State salary & previous exp. A. Robb & Sons, Amherst, N. S., Can.

Wanted—A 1st-class draftsman; must be used to designing modern work. None but men with good references need apply. Box 27, AM. MACH.

An exp. draftsman with tech. education, 4 yrs. exp. as mach., now engaged on metal-working mach., desires a change. J. J. D., Carrier 8, Fitchburg, Mass.

Wanted—Foreman for a brass foundry. Address, giving experience, age, reference and all information which is to the point, G. Lundberg, The Winthrop, 125th street and 7th Ave., N. Y. City.

Wanted—A thoroughly capable and practical draftsman and designer, one familiar with machine tools preferred; state experience, and salary desired. Manufacturer, AMERICAN MACHINIST.

Draftsman—Wanted a first-class mech. draftsman, experienced in modern high-speed engine work and general machinery. Address, giving full particulars as to age, experience, and wages expected, Box 29, AMERICAN MACHINIST.

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OVER 1500 IN USE.
Three Styles, 15 lb. to 500 lb. Heads.
Our FORGES heat irons fast enough to keep Hammers and Men fully employed. Send for Catalogue and Prices.
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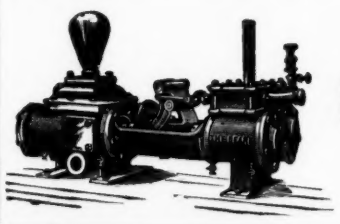

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106 Illustrations. 8vo, Cloth. $2.50.
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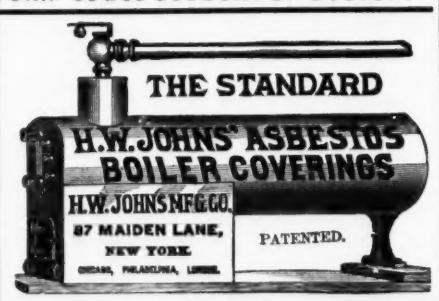

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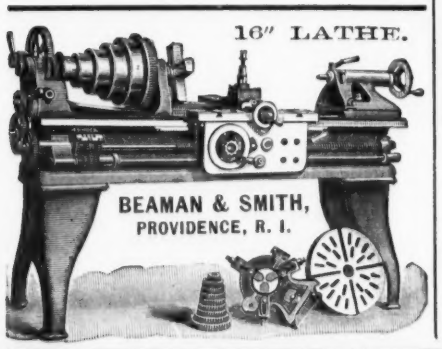
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.



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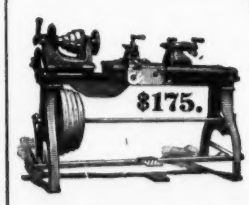
The Finest Tool & Die STEEL



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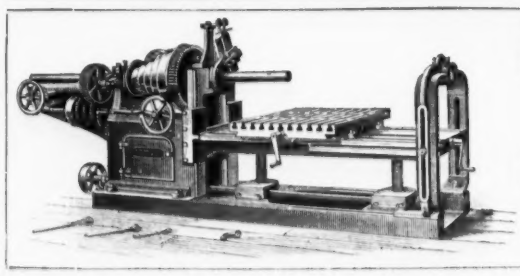

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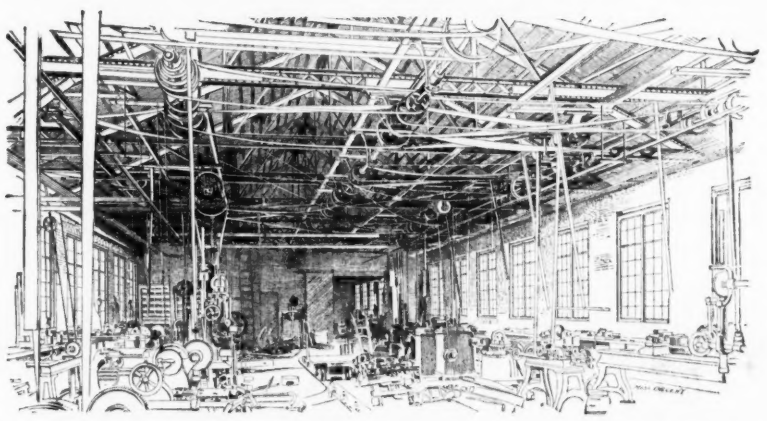

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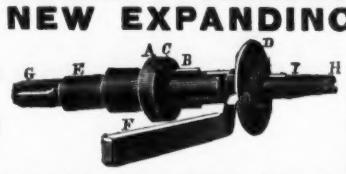

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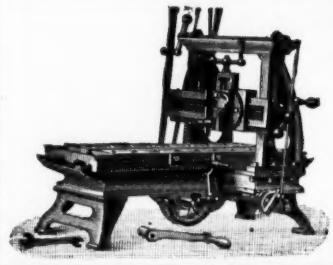

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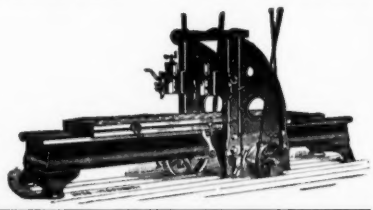

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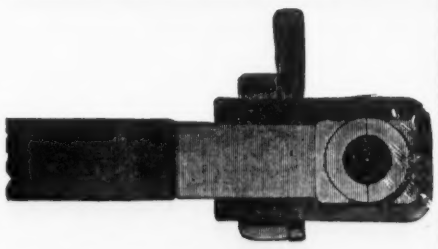

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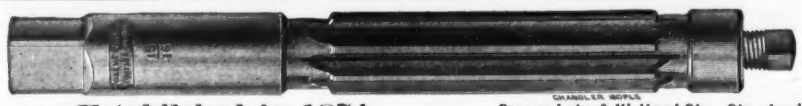

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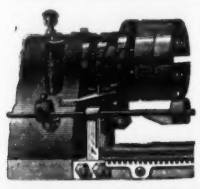

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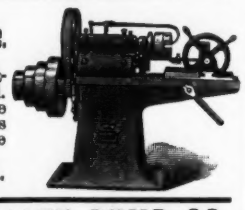

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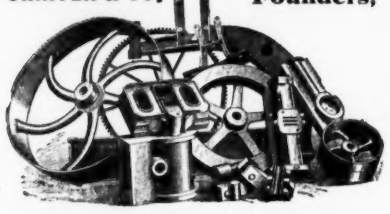

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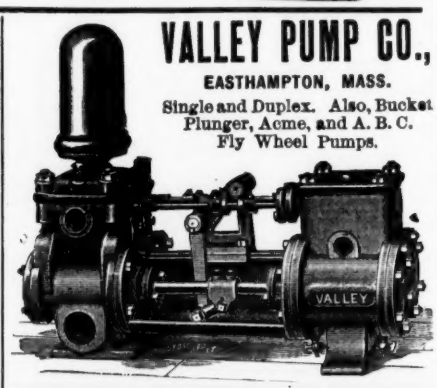

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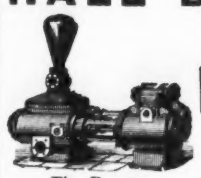

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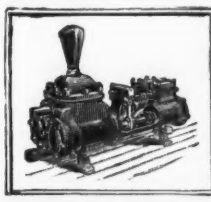

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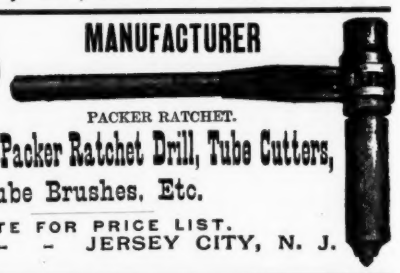

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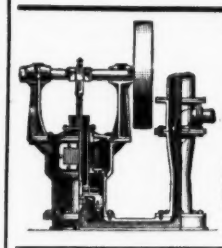

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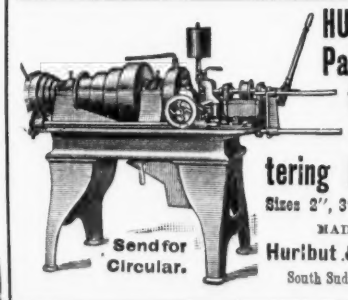

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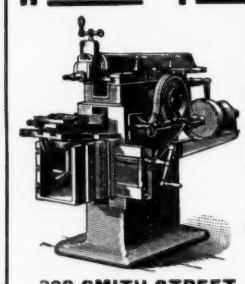

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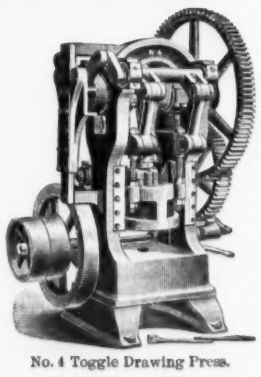

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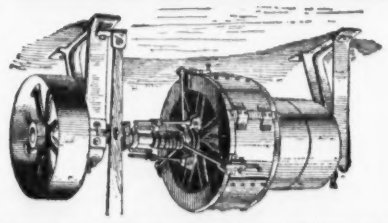

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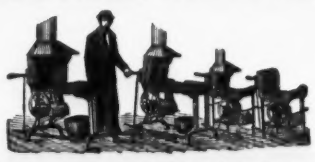

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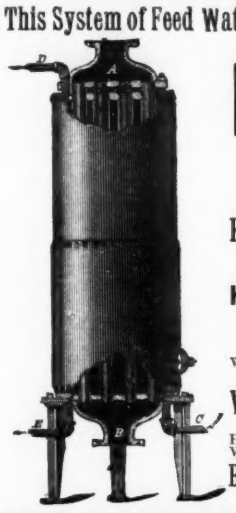

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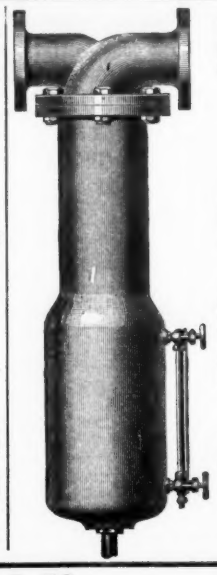

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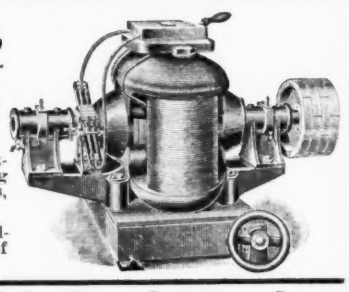

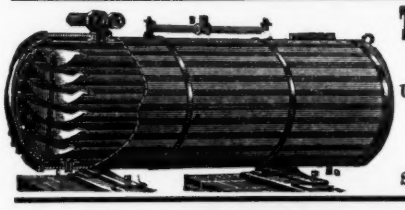

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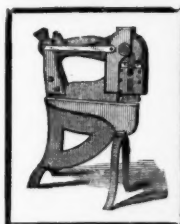

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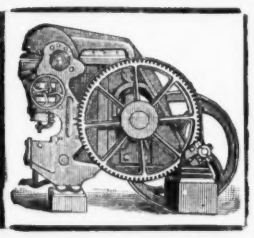

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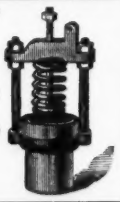

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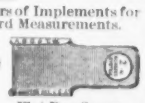

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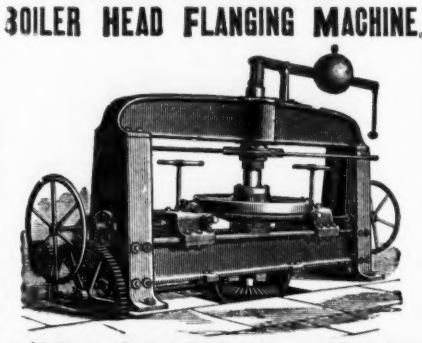

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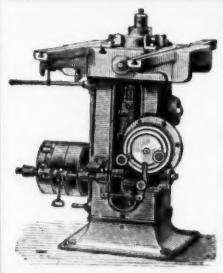

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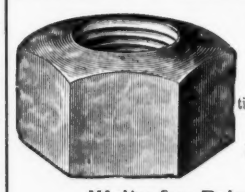

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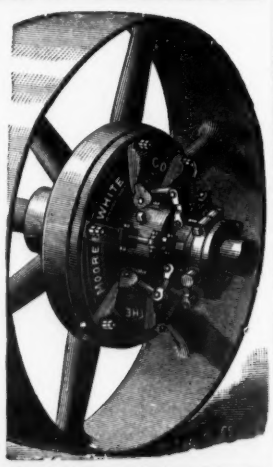

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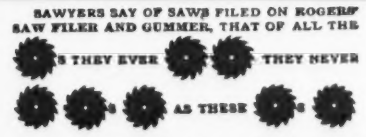

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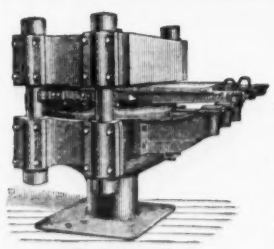

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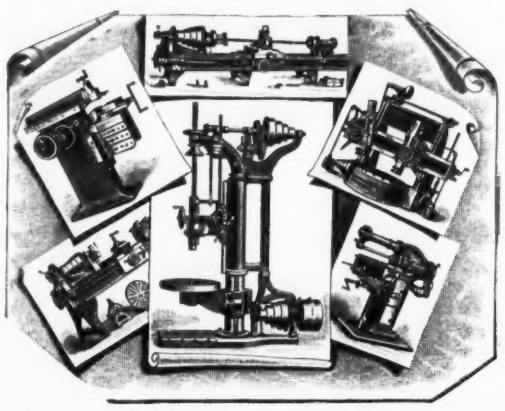

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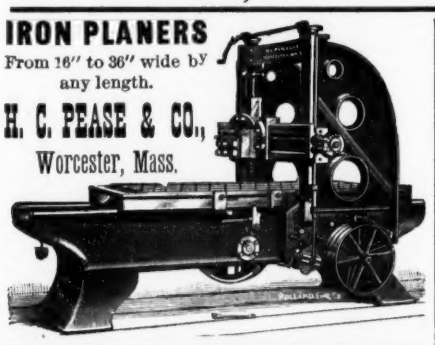

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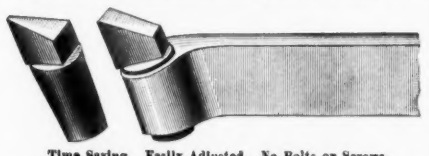

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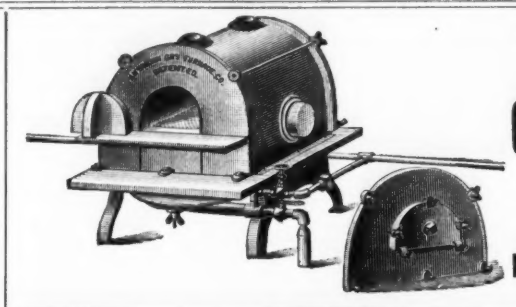

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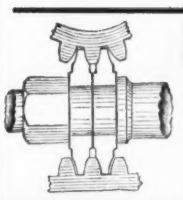

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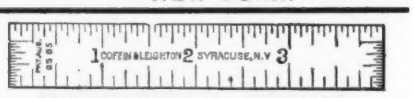

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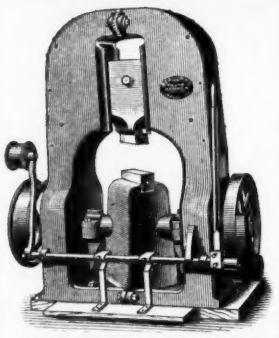

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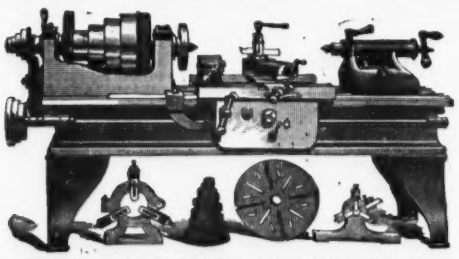

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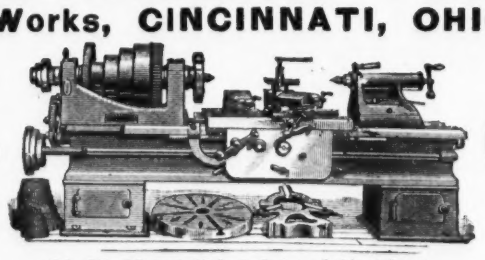

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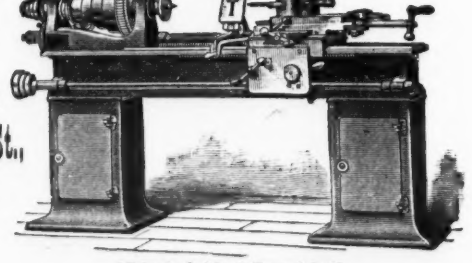

18-inch Cabinet Turret Lathe.
Taper Attachment, Automatic Feed, Lever and Screw Movement, most complete brass lathe on the market.

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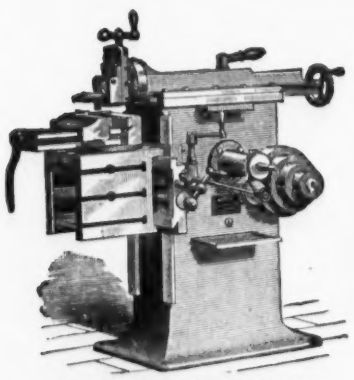

15 and 20-inch Crank Shaper.
Stroke changed and adjusted while running. Stroke at all times positive.
Invariably plane to a line.
Detachable Tables.

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TURRET LATHES
IRON PLANERS
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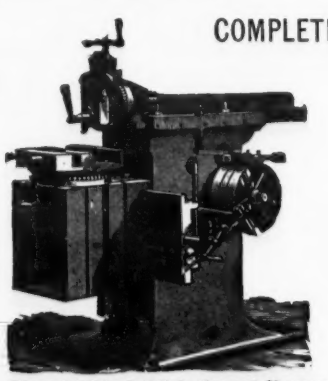
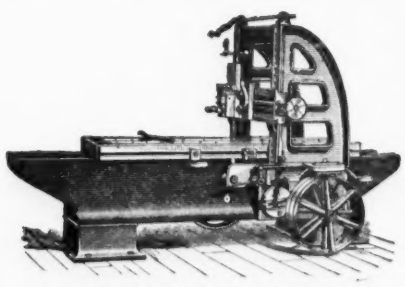


20, 26 and 32-inch Triple Geared Shapers.
Stroke changed while machine is running. Shaft can be passed through head of machine and key seat cut in same to any length. Extra heavy vises. Tables slotted on all sides.



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Extra deep beds and tables. Powerfully geared. Plenty of Metal and designed for extra heavy duty. All Feeds and Shipper operated from both sides.
Improved Device for holding Planer Bolts.

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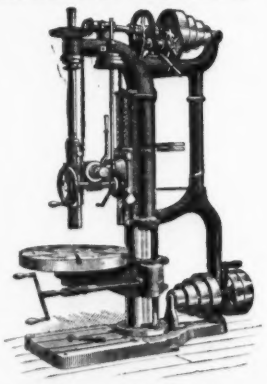

25, 28, 32 and 40-inch Drills.
Automatic stop to feed. Quick return on right side. Table operated from front. Large cones and long belts.

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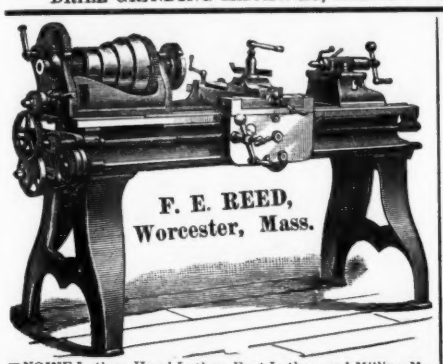

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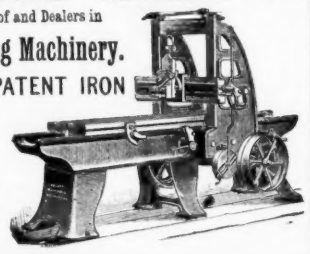

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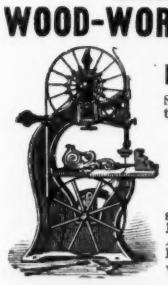

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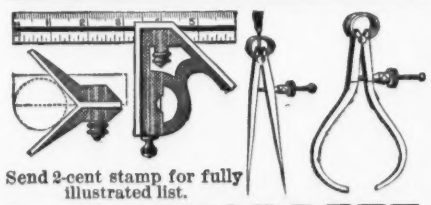

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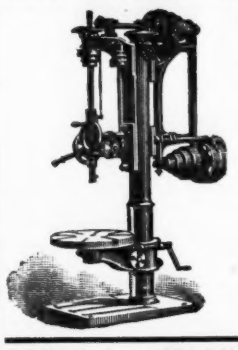

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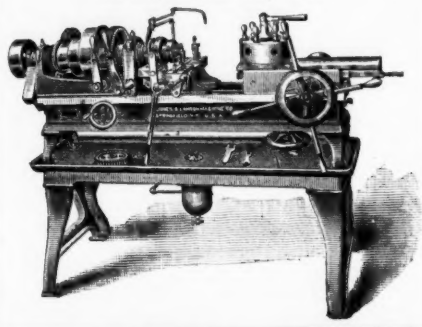

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A new, ingenious and handy tool for drilling small holes, running at any speed desired. Operator can handle the work with one hand, and the drill with the other.
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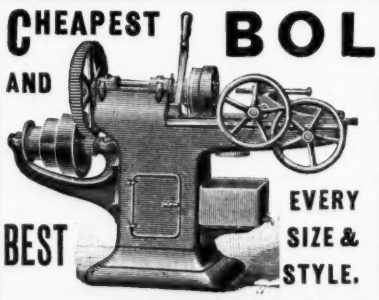

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Nos. 1 and 3 will cut all sizes from ⅛ to 3 inch

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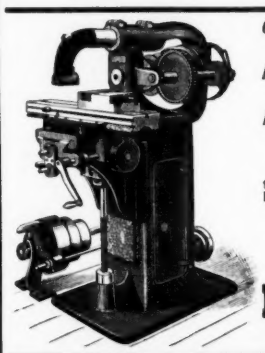

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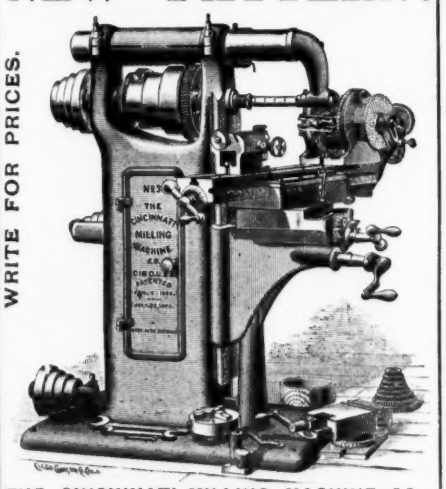

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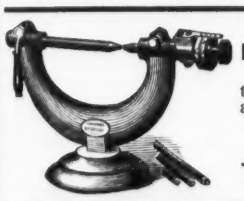

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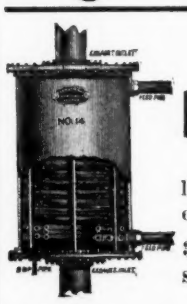

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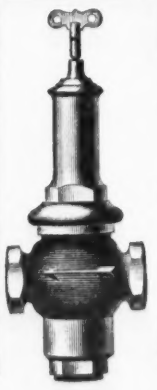

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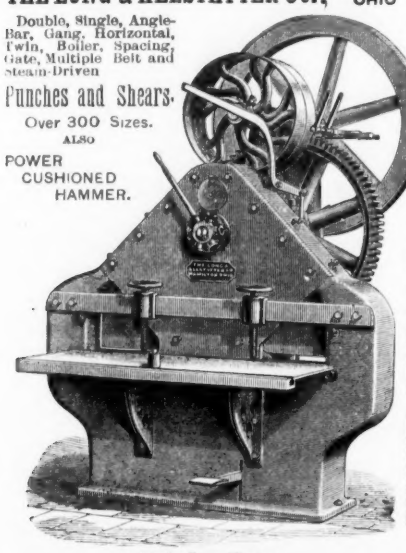
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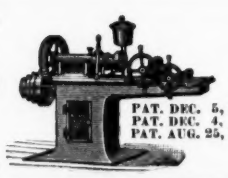
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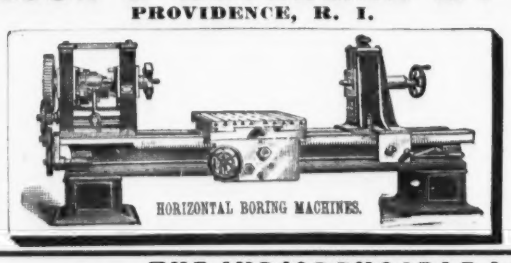
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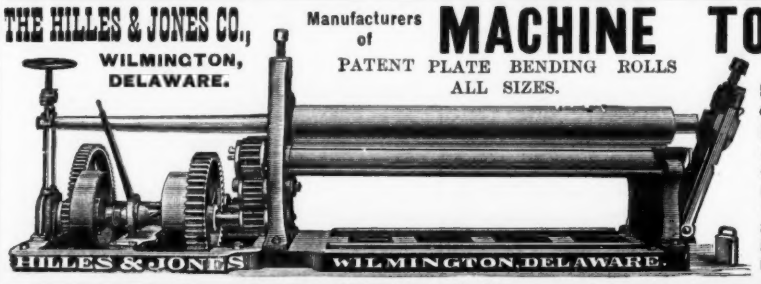
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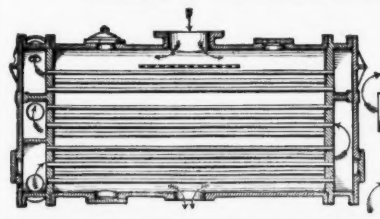
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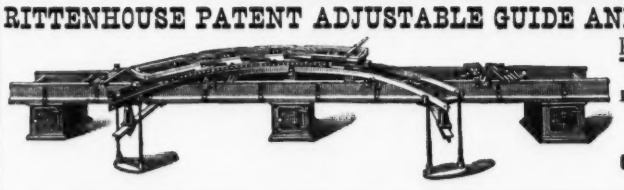
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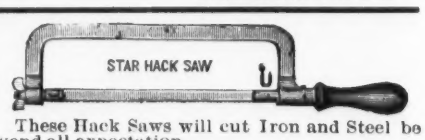
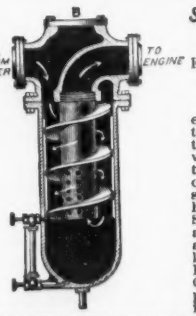


These Hack Saws will cut Iron and Steel beyond all expectation.
Iron working mechanics everywhere must and will use them. They do the work of files at one-tenth the cost, and in one-tenth the time. One Patent Nickel-plated Steel frame, and one dozen 8 inch Blades, sent by mail, prepaid, on receipt of $1.50. Hardware dealers will furnish them at at the same price. All saws marked with a star, and bearing our name are fully warranted.
MILLERS FALLS CO.,
93 Reade Street, New York



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For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.
Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
KEYSTONE ENGINE AND MACHINE WORKS
Fifth and Buttonwood Streets, Philadelphia,
Or, A. T. ARTHUR, Selling Agent, 18 Cortlandt St., N. Y

THE STRATTON SEPARATOR
DELIVERS
DRY STEAM
To your engine or for any other purpose, no matter HOW LONG YOUR STEAM PIPE, or how much your BOILER MAY PRIME. An absolute safeguard. A source of economy.
—THE—
Stratton Separator Co.,
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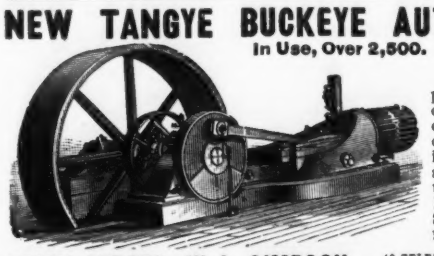
NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES

In Use, Over 2,500.

25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for Driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. Address, BUCKEYE ENGINE CO., Salem, Ohio.

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KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland, and Virginia.

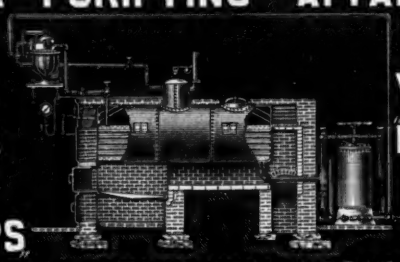
THE ALBANY STEAM TRAP Co

BOILER PURIFYING APPARATUS.

ALSO MANUFACTURERS OF

"RENEWABLE SEAT VALVES"

"RETURN STEAM TRAPS"



"DUPLEX" WATER FILTERS

"PUMP GOVERNORS"

AND

"STEAM PUMPS"

SEND FOR CURCULARS. ALBANY STEAM TRAP CO. ALBANY, N.Y.

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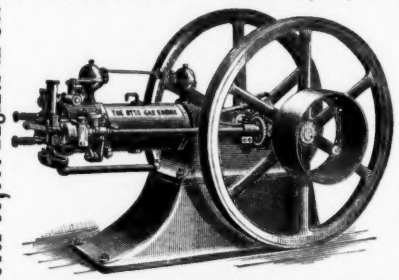
33d and Walnut Sts., PHILADELPHIA.

Branch Office, 151 Monroe St., CHICAGO.

New York Agency, 18 Vesey St., N. Y.

Over 35,000 Engines in Use



Guaranteed to consume 25 to 75 per cent. less Gas than any other Gas Engine doing the same work.

GASOLINE and GAS ENGINES

Our new Engines are hustlers. A 6 x 7 inch Engine, now running 100 feet of shafting. Boring Mills, Planers, Lathes, Drill Presses and Milling Machines for 20 Machinists, on 6 gal. Gasoline per day, costing only 60 cts. Write for information. *Mention this paper.*

Van Duzen Gas & Gasoline Engine Co.

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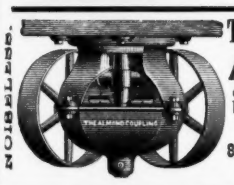

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A NEW quarter turn motion to replace quarter turn belts and bevel gears.

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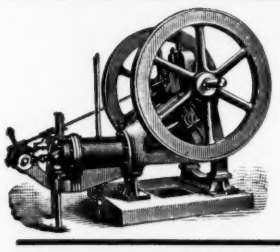
ATKINSON CYCLE GAS ENGINE.



Four strokes of piston in one revolution of crank-shaft, expanding the charge to more than the original volume, driving out *all* the products of combustion, and giving a working stroke at every revolution and in half the time required by any other engine. *Send for Illustrated Circular.*

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FOR LIGHT, SENSITIVE AND RAPID DRILLING.

1, 2, 3, 4 or more Spindles, Sensitive or Automatic Feed.

To drill from 0 to 1-2 inch holes.

The *Latest* and *Best*; most convenient, sensitive and durable Drill on the market.

Have Balanced Spindles and Balanced Tables.

Write for prices and description, or for Special Machinery.

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PLAINVILLE, CONN.

Manufacturers of Machine Tools and Special Machinery.

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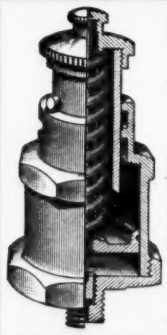

Will Save Its Cost In Oil alone Several Times per Annum.

SAVES ALSO IN LABOR AND COST OF COTTON-WASTE, PREVENTS DRIPPING AND SPATTERING.

A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.

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ENGINE LATHES,
BRASS LATHES,
BORING AND TURNING MILLS,
SCREW MACHINES,

on hand and in process of construction.

BRIDGEPORT MACHINE TOOL WORKS,

E. P. BULLARD, PROPRIETOR. BRIDGEPORT, CONN.

SECOND-HAND MACHINERY.

MODERN STYLE. GOOD RUNNING ORDER.

Will be closed out low.

Putnam Engine Lathe, 36 in. swing, 18 ft. bed, c'p'd rest, cross feed, 36 in. chuck, complete.
New Haven Engine Lathe, 25 in. swing, 10 ft. bed, "
Storer " " 24 in. " 12 ft. " "
Hewes " " 20 in. " 8 ft. " "
Chelsea " " 18 in. " 8 ft. " "
New Haven " " 16 in. " 7 ft. " "
Lathe & Morse " " 15 in. " 5 ft. " "
Am Tool Co. No. 2 Cabinet Turret Lathe, "
Worcester Planer, 42 in. wide, 12 ft. long, auto. feeds, two belts, table very heavy.
New Haven Planer, 32 in. x 12 ft., complete.
Fitchburg " 30 in. x 8 ft., "
Pond Machine Tool Co. " 24 in. x 7 ft., late pattern.

NEW TOOLS.

(Latest Patterns.)

Lathe & Morse Engine Lathe, 27 in. swing, 12 ft. bed.
Fitchburg Engine Lathe, 24 in. swing 12 ft. bed, new pattern.
Wright " " 24 in. " 12 ft. " " complete.
Fitchburg " " new pattern, 14-16 18 in. swg, "
Prentice " " 12-14 16-18 in. swing, "
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Brass Lathe, 15 in. with Square Arbor and Chasing Bar.
" 15 and 17 in. with Turret and Chasing Bar.
" 13 in. with Turret for Rod and Chuck work.
Fitchburg Planer, 24 in x 6 ft., 25 in. x 8 ft.
Powell " 24 in. x 6 ft., 30 in. x 8 ft., 36 in. x 12 ft.
Lathe & Morse " 22 in. x 5 ft., 24 in. x 6 ft.
Prentice Drills, 20-21-25 28-32 in. swing.
Snyder " 28 in. swing complete.
Prentice Radial Drills, 5 and 6 ft., (now under way).
Fitchburg 14 in. Trav. Head Shaper, complete.
Eberhardt Crank Shapers, 16 and 24 in.
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Milling Machines, Universal and Plain.
Bolt and Pipe Cutters, all sizes.

Send for Complete January List.

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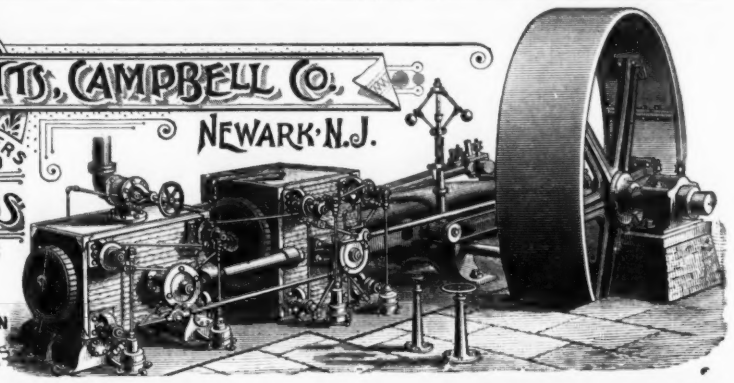
MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

CONTRACTS TAKEN FOR COMPLETE POWER PLANTS



Eclipse Corliss Engine.

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NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

Send for Circulars.

ICE-MAKING AND REFRIGERATING MACHINERY.

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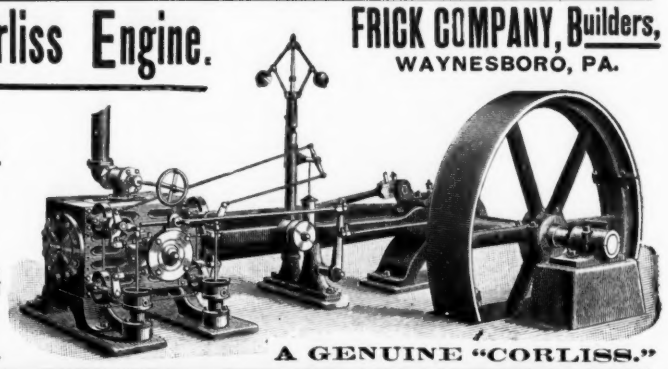

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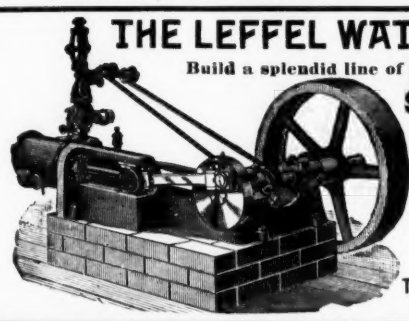
THE LEFFEL WATER WHEEL & ENGINE CO.

Build a splendid line of SELF-CONTAINED SIDE-CRANK ENGINES —AND— RETURN-FLUE BOILERS



8, 12, 16, and 20 Horse Power.

High in Grade. Low in Price. Strictly first-class. In design and construction SUPERIOR to all others. Write for ENGINE PAMPHLET.

Address us in full as follows:

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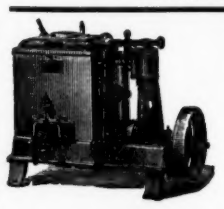

Automatic Steam Engine. Kerosene Oil or Natural Gas Fuel

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The Best Power for Farmers, Printers, Carpenters and Manufacturers.

Automatic in both fuel and water supply, requiring but little attention after once started.

1, 2, 4, 6 and 8 H. P. Single.
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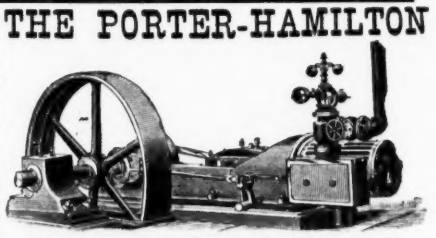

The best engine in America for Heavy Work.

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A STRICTLY FIRST-CLASS ENGINE.

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NELSON W. TWISS,

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Send for Price before Purchasing Elsewhere.

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CHANDLER & TAYLOR CO'S SELF-CONTAINED STEAM ENGINES

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IN STOCK FOR QUICK DELIVERY.

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TAPS TO FIT MACHINE SCREWS ALL SIZES

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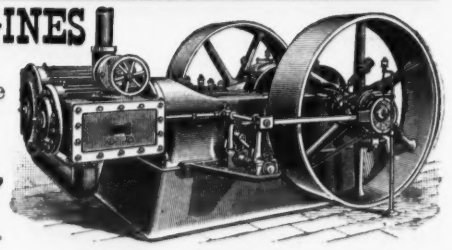
BALL AUTOMATIC ENGINES

WORKS: ERIE, PA.

High-Pressure, Compound and Triple Expansion, Condensing and Non-Condensing.



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No. 1 Universal Milling Machine, with overhanging arm.
No. 3 Universal Milling Machine.
No. 2 Plain Milling Machine.
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No. 2 Universal Grinding Machine, Improved.
No. 2 Surface Grinding Machine.
No. 3 Surface Grinding Machine.
No. 3 Universal Cutter & Reamer Grinder.
No. 3 Automatic Gear Cutting Machine.
No. 1 Screw Machine.
No. 2 Screw Machine.
No. 5 Screw Machine.
No. 2 Automatic Screw Machine.
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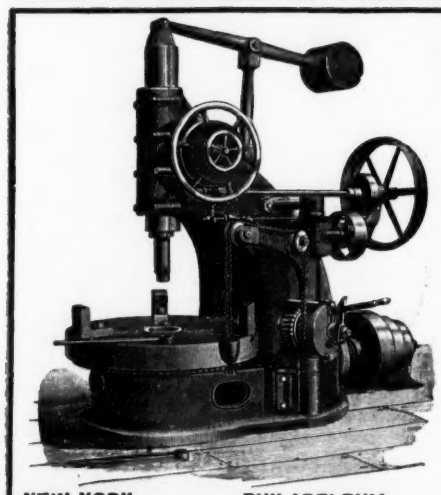
16-inch Engine Lathe.
Universal Hand Lathe.
Screw Slotting Machine.

These machines were not specially selected or prepared for exhibition, but were the same in finish and design as those in stock or approaching completion at our works.



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MACHINE TOOLS.

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The Original Unvulcanized Packing

CALLED THE STANDARD—As it is the Packing by which all others are compared.

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$150.00 REWARD.

The remarkable increase in the sale of our Improved Machine Tools has induced us to still further place their merits before every user of this class of machinery both in America and Europe.

In order to accomplish this we desire an advertisement out of the stereotyped order.

In view of this fact we will, on July 1st, 1891, pay one hundred dollars ($100.00) for the first and fifty dollars ($50.00) for the second best plan for advertising our line of Improved Tools.

The plans must embody three conditions: First, they must be NOVEL; Second, FEASIBLE; Third, DIGNIFIED.

Competition open to every one, except those in our employ. Communications may be addressed to either of our houses.

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Works: CINCINNATI, OHIO.

N. B.—See "Advertisement", page 16.

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EBERHARDT'S PATENT.

With rare exception, this machine is cutting ALL

ELECTRIC MOTOR GEARS

MADE.

In use by the following for cutting these gears:

The Pratt & Whitney Co.,
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H. P. Nail Co., "
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Putnam Machine Co., and others.

GOULD & EBERHARDT, Newark, N. J.

THE PRATT & WHITNEY CO.

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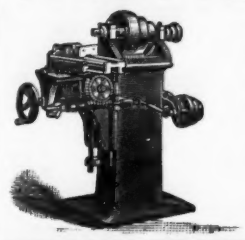

Manufacture Plain Milling Machines, with hand and power feed, of several sizes. Index, double face, vertical face, double spindle and shuttle race Milling Machines. Cam Cutters and Profiling Machines of several kinds. Milling Machines, Vises and Centers. Milling Cutter and Twist Drill Grinding Machines.

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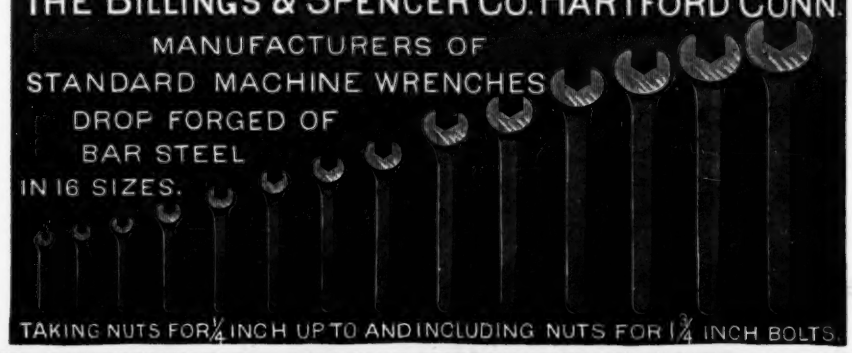
KNURLING TOOLS. CUTTERS FOR THE TEETH OF SPUR WHEELS.

WESTERN BRANCH, 100 WEST WASHINGTON ST., CHICAGO, ILLS.

THE BILLINGS & SPENCER CO. HARTFORD CONN.

MANUFACTURERS OF
STANDARD MACHINE WRENCHES
DROP FORGED OF
BAR STEEL
IN 16 SIZES.



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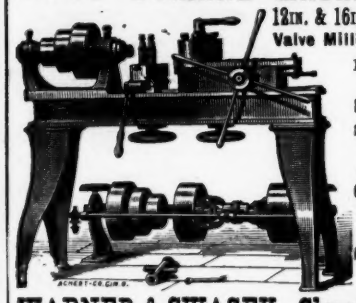

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Valve Milling Mach's
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Revolving Chucks for Globe Valves
Two-Jawed Chucks,
Small Tools and Fixtures.

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Formerly of Worcester, Mass.

MANUFACTURERS OF

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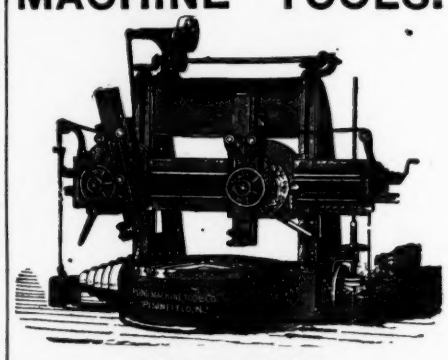

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Radial Drills, Planers, Lathes, Heavy & Powerful, from new patterns of the latest and best designs.

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FROM 16 to 48 IN. SWING.

Cuts, Photographs and Prices furnished on application.

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Key-Seating Machines and 20 in. Drills

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SEND FOR LIST OF
New and Second-Hand
Lathes, Planers, Drills,
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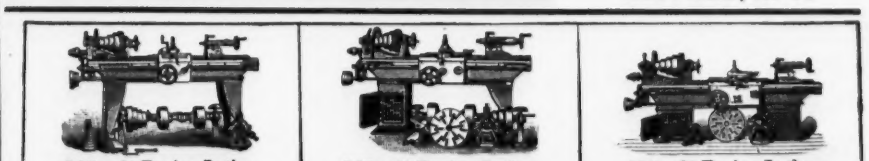

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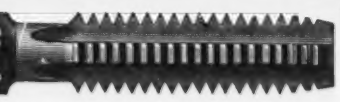

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